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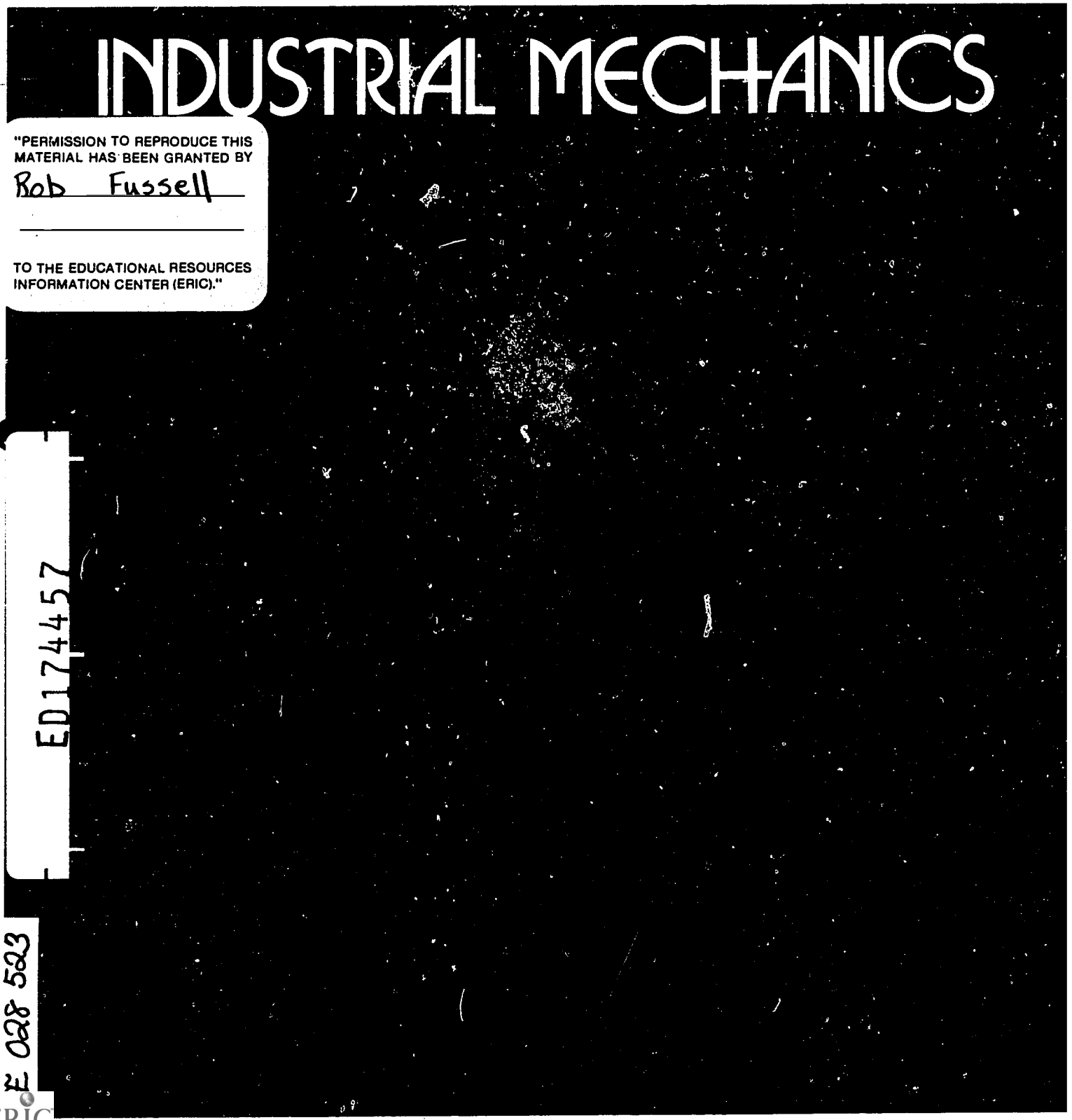
ABSTRACT

This guide, developed by the Oregon Department of Education, is intended to assist the vocational teacher in designing and implementing a cluster program in industrial mechanics. It suggests teaching ideas and is aimed at high school students, as well as those wishing to enter community college, university, or apprenticeship programs. The guide is divided into four sections: (1) cluster organization and implementation; (2) instructional emphasis areas; (3) assessment; and (4) appendix. The Cluster Organization and Implementation section talks about goal-based planning and includes a proposed cluster curriculum, a sample curriculum schedule and planned course statement, allied support causes, information about individualized instruction, and current Oregon Manpower Data. The Instructional Emphasis Areas section contains suggested course goals, performance indicators and suggested learning activities in safety, basic mechanical skills, mechanical maintenance techniques, measurement, machine tools, mechanical systems, electrical systems, fluid power systems and career preparation. Section three is focused on Assessment and is followed by the appendix, which contains three documents: (1) job descriptions; (2) machines and equipment; and (3) instructional analysis for organizing learning experiences. (Author/HM)

# OCCUPATIONAL CLUSTER GUIDE

# INDUSTRIAL MECHANICS





# INDUSTRIAL MECHANICS

# CLUSTER GUIDE

Spring 1979

Verne A. Duncan
State Superintendent of
Public Instruction

OREGON DEPARTMENT OF EDUCATION
Salem, Oregon 97310

## STATEMENT OF ASSURANCE

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## FOREWORD

Leaders in business and industry expect high school graduates to be productive workers contributing to the economy and their chosen occupational fields. If high schools are going to meet the needs of students, education—especially for eleventh and twelfth grade students—needs to offer opportunities to develop skills for a broad range of occupations.

As taught in Oregon's high schools, occupational clusters are designed to prepare students for job entry. The Oregon Department of Education analyzed the basic elements of hundreds of jobs with similar characteristics, grouping these into occupational clusters according to entry-level requirements. From the resulting list, Department staff, in cooperation with the Department of Labor, Division of Employment and Statistics, selected clusters geared toward current job opportunities around the state.

To develop this cluster guide, key occupations were identified, activities and resources were selected. The guide suggests teaching ideas, and is aimed at high school students, as well as those wishing to enter community college, university, or apprenticeship programs. For further information, please contact Charles Howell, Industrial Mechanics Specialist at the Department.

## STATE ADVISORY COUNCIL FOR CAREER AND VOCATIONAL EDUCATION

H. David Smith
PO Box 311
Philomath, OR 97370
Phone: 929-3161

Donald Staudenmier
421 Portland Labor Center
Portland, OR 97201
Phone: 227-3291

Linda Rasmussen
7824 N Hereford
Portland, OR 97303
Phone: 242-6322

Jess Angel
PO Box 20
Dairy, OR 97625
Phone: 545-6514

Judith Brown
2326 NW Westover Road
Portland, OR 97210
Phone: 221-0521

Betty Pritchett
26000 SE Stark
Gresham, OR 97030
Phone: 667-1561

Kenneth Light
Oretech Branch PO
Klamath Falls, OR 97601
Phone: 882-6321, Ext. 212

Mary Cruchiolla
712 Main Street
Oregon City, OR 97045
Phone: 656-0361

James Davison
2500 "E" Street
Baker, OR 97814
Phone: 523-6336

Elmer Beckett
1831 SE 6th
Portland, OR 97214
Phone: 238-6100

Louise Lothspeich
3830 SE 14th Avenue
Portland, OR 97202
Phone: 233-8903

Gene Hilfiker
3405 Deer Park Drive SE
Salem, OR 97310
Phone: 378-4809

Dave Phillips
16th and Jerome
Astoria, OR 97103
Phone: 325-0910

Burr Fancher
PO Box 967
Albany, OR 97321
Phone: 967-4381

Nancy Ryles
11505 SW Jody Street
Beaverton, OR 97005
Phone: 646-3061

Robert Geltz
320 Public Service Bldg.
Salem, OR 97310
Phone: 378-8381

Hector Hinojosa
Emerald Hall 270
Eugene, OR 97403
Phone: 686-3532

Pina Williams
6318 SW Corbett
Portland, OR 97201
Phone: 244-7541 or 287-0318

Brenda Green
PO Box 87
Salem, OR 97308
Phone: 399-3041

Betty Aikin
6515 NE 36th Street
Portland, OR 97211
Phone: 754-3648 or 281-6859

Irene GrosJacques
2045 Silverton Road NE
Salem, OR 97310
Phone: 378-3830

Peter Quaempts
212 SW Isaac
Pendleton, OR 97801
Phone: 276-2491

Michael Wooton
187 Antelope Lane
Roseburg, OR 97470
Phone: 673-6425

Diane Detering
21090 Coburg Road
Harrisburg, OR 97446
Phone: 995-6418 or 754-3548

Gene H. McIntyre
495 State Street
Fifth Floor
Salem, OR 97310
Phone: 378-3921

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Industry and education worked together to develop this guide. Industrial representatives, special consultants, secondary school administrators and teachers participated in analysis studies, committee work sessions and individual reviews of all phases of development.

The final draft was researched and written by Frank Bishop, under the direction of John Barton, Consultant, Curriculum and Instructional Materials Development, Oregon Department of Education.

Special recognition is given to members of the Mechanical Steering Committee and George Warren, Clackamas Community College, whose advice and direction were invaluable.

Listed below are the analysts and the Task (Occupational) Analyses which they compiled:

| | |
|---|---|
| Tom Chereck | Refrigeration Mechanic |
| Fred DeWitt | Construction Equipment Mechanic and Diesel Mechanic |
| Marvin Greenlee | Auto Mechanic |
| Tom Kingsbury | Aircraft Mechanic |
| Bill Lauer | Small Engine Mechanic |
| Jim Mason | Office Machine Repairer |
| Dusty Samard | Millwright |
| Mike Ward | Hydraulics Mechanic |

## PROCEDURES FOR USING THE GUIDE

This guide is intended to assist the vocational teacher in designing and implementing a cluster program in industrial mechanics. It is divided into four sections: cluster organization and implementation, instructional emphasis areas, assessment, and appendix.

The Cluster Organization and Implementation section talks about goal-based planning, and includes a proposed cluster curriculum, a sample curriculum schedule and planned course statement, allied support courses, information about individualized instruction, and current Oregon Manpower Data.

The Instructional Emphasis Areas section contains suggested course goals, performance indicators and suggested learning activities in safety, basic mechanical skills, mechanical maintenance techniques, measurement, machine tools, mechanical systems, electrical systems, fluid power systems, and career preparation.

Section three, Assessment, is followed by the appendix: (a) job descriptions from the *Dictionary of Occupational Titles,* (b) suggested machines and general equipment for a shop, and (c) instructional analysis of the skills and knowledge common to the key occupations.

CONTENTS

# CLUSTER ORGANIZATION AND IMPLEMENTATION

## GOAL-BASED PLANNING FOR INDUSTRIAL MECHANICS PROGRAMS

Goals are guideposts—they give purpose and direction to planning activities. Goals provide a common language for discussing the merits of various activities as such activities are carried out.

In industrial mechanics, just as in any other program offered by an educational system, a sense of purpose and direction is essential to good planning. But what are these purposes and directions? Where do they come from? Why should the industrial mechanics teacher be concerned? These are questions to be answered before effective planning of an industrial mechanics curriculum can proceed.

Each teacher must realize that planning an industrial mechanics curriculum cannot begin and end only in a given classroom. It needs to be done with a sense of similar planning in other classrooms and districts in the state.

Goal-setting provides districts a common reference for planning. In goal-based planning, teachers would consider four levels of goals: state goals, district goals, program goals and course goals.

**State Goals** answer the question: What does the Oregon Department of Education think a student should get out of public schooling in Oregon?

**District Goals** answer the question: What do the local community and its schools think a student ought to get out of local schooling, and how is that to relate to state goals?

**Program Goals** answer the question: What do the local curriculum planners and industrial mechanics teachers think a student ought to get out of industrial mechanics and how is that to relate to district goals?

**Course Goals** answer the question: What do the industrial mechanics teachers think a student ought to get out of "The Cooling System" and how is that to relate to program goals?

Where, then, does competency fit?

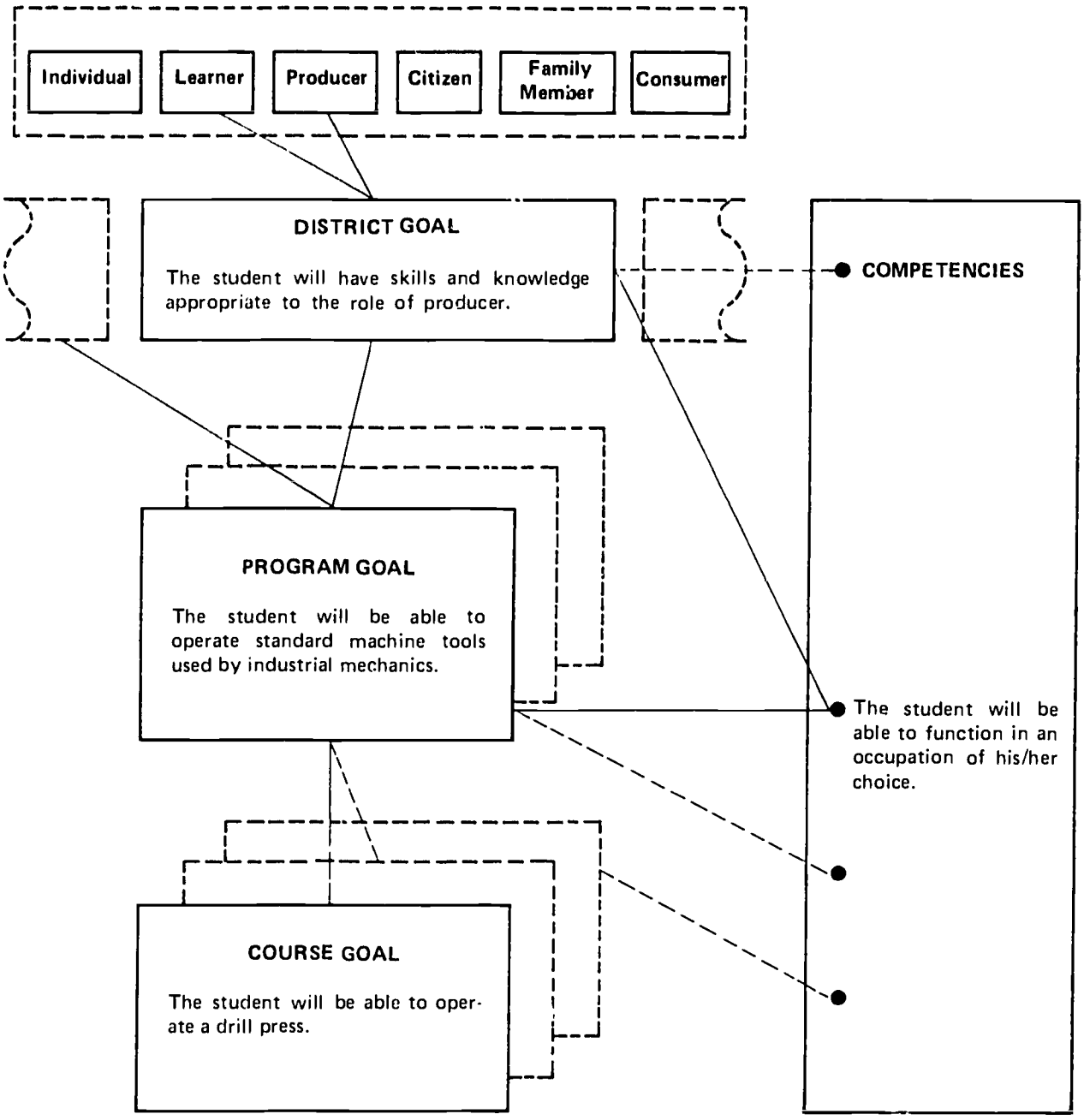
Competency is one of three graduation requirements. Districts plan and evaluate instruction by means of goals, goals local districts write. Districts determine whether students get diplomas by means of competency, credit and attendance—requirements local districts set.

Competency means being capable, fit. For students in Oregon, it means having demonstrated that they have the knowledge and skills which the community considers necessary for life roles. The knowledge and skills may be acquired from several courses.

A competency is a local statement describing what ALL students must demonstrate. It is not a competency in Oregon if only some students must

demonstrate it—say, only those who study "The Cooling System." In this case, it would be a course goal.

For example, in Industrial Mechanics:




Goals are intended to help teachers, program specialists and administrators plan programs. Goals promote a framework for planning that can be shared by all those doing similar planning. Goals help in planning for individual student goals and interests, to be done within the limits of available resources. It is important that industrial mechanics specialists (teachers) be directly involved in developing district, program and course goals so that the industrial mechanics cluster is coordinated with other program areas. Goals for industrial mechanics should not be used to limit what is planned; rather, they should be a starting point.

## WHAT IS THE INDUSTRIAL MECHANICS CLUSTER?

An occupational cluster is a group of occupations having similar tasks.

The industrial mechanics cluster groups occupations by tasks having to do with mechanical, electrical and fluid-power systems. Component parts of such systems include shafts, bearings, seals, belts, pulleys, clutches, gears and levers.

Prominent occupations in the industrial mechanics cluster include:

auto mechanic
aviation mechanic
construction equipment mechanic
diesel mechanic
hydraulics mechanic
millwright
office machine mechanic
refrigeration mechanic
small engine mechanic

A sampling of tasks from the occupations within the cluster shows a requirement for the ability to make precision measurements. For example:

measure engine vacuum with vacuum gauge (auto)
use pressure gauge to inspect oxygen system (aviation)
use pressure gauge to inspect radiator for leaks (construction equipment)
measure blower pressure with manometer (diesel)
adjust system with pressure gauge (hydraulics)
calibrate pressure in precision pump with pressure gauge (millwright)
adjust drive belt tension with tension gauge (office machine)
measure pressure in metering device with pressure gauge (refrigeration)
measure fuel pump pressure with pressure gauge (small engine)

Upon completing an occupational cluster, students should have developed knowledge and skill common to any occupation within the cluster and should be prepared to seek work or further training in the occupation of their choice.

## INDUSTRIAL MECHANICS OCCUPATIONS CLUSTER CURRICULUM

This guide is designed to show teachers what specific knowledge and skills qualify students for entry-level employment in the industrial mechanics occupations (see page 15). The teacher, with the help of an advisory committee, can organize a curriculum to instruct students according to individual needs.

An industrial mechanics program should include:

Occupational exploratory experiences in grades seven through ten. This is the time for students to develop career goals and plans. Courses in industrial arts, general business, industrial English, mathematics, and science provide a foundation for the industrial mechanics cluster in grades 11 and 12.

Occupational guidance. Guidance helps students learn more about themselves, and helps them choose occupational fields which are challenging and fulfilling.

Occupational specialty course in grades 11 and 12. Courses should be offered two periods per day or ten hours per week. This is a minimal amount of time in which to study and acquire that experience called for by the course goals.

Allied supporting elective course in grades 10, 11, 12. Students should be offered supplemental courses to sharpen particular interests and talents, and to help them attain occupational goals. (See page 9 for a list of recommended allied elective courses.)

Cooperative work experience programs. These programs provide on-the-job training and can help improve career decision-making skills. Work experience should be a part of the required time blocks as electives.

A suggested Industrial Mechanics Cluster Curriculum Plan is presented on the following page.

## SUGGESTED CURRICULUM SCHEDULE

| Period | Grade 7 and 8 | Grade 9 | Grade 10 | Grade 11 | Grade 12 |
|---|---|---|---|---|---|
| I | Language Arts | Language Arts | Language Arts | Language Arts | Language Arts |
| II | Social Studies | Mathematics ! | Personal Finance | Social Studies | ~~Metalwork (Machining)~~ |
| III | Mathematics | Citizenship | Science | ~~Electricity Electronics~~ | ~~Work Experience~~ |
| IV | Physical Education | ~~Industrial Arts (Exploratory)~~ | ~~Industrial Arts (Drafting)~~ | ~~Business Education~~ | ~~Electricity Electronics~~ |
| V | Science | ~~Elective~~ | Health Education | ~~Metalwork (Welding)~~ | Social Studies |
| VI | ~~Industrial Arts (Exploratory)~~ | Health Education | Citizenship Streets/Highway | Industrial Mechanics Cluster (Preparation) | Industrial Mechanics Cluster |
| VII | Art, Home Economics | Elective | Physical Education | | |

Fundamental Courses

Supportive Courses

Formative Courses

Occupational Specialty Courses

The Oregon Department of Education recognizes that each local school district will encounter unique scheduling problems when implementing an occupational cluster program at the secondary level. The *State Plan for Vocational Education* sets guidelines for time blocks; local districts exercise flexibility within these limitations to adapt to specific needs.

## PLANNED COURSE STATEMENT
## (SAMPLE)

Cluster: Industrial Mechanics

Area of Emphasis: Mechanical

Course Title: Mechanics Skills

Length of Course: 1 year

Number of Credits: 2

Grade Level(s): 11

Prerequisite: _____

Course Designation

_____ Required

_____ Elective

Alternative Learning Opportunities

_____ Independent Study

_____ Work Experience

Course Overview

Mechanics use many types of tools, ranging from simple hand tools to complicated equipment. Mechanics also consult repair manuals and parts catalogs. Whether the problem is mechanical, electrical or fluid in nature, the mechanic is expected to work in these areas maintaining and repairing machines and equipment. The mechanic operates machines to test moving parts and listens for and locates malfunctions. The mechanic disassembles machines; examines parts (gears, guides, switches, shafts, bearings, etc.) for wear and defects; repairs, adjusts or replaces parts using specialized tools, power tools, and soldering and welding equipment; cleans and lubricates moving parts; and may instruct others regarding care and operating procedures.

Success as a mechanic will depend on the ability to diagnose mechanical as well as electrical problems. Success also depends on the ability to do tedious work under a variety of working conditions for extended periods of time. It is precision work that requires good judgment and a delicate touch. Most of the above mentioned areas will be included in this course, and students will learn skills necessary to work on office machines, air conditioning equipment, automobiles, appliances, hydraulic equipment, aircraft engines, small engines, etc.

Program Goal

Students will be able to operate, service, and repair machines and equipment.

## SUGGESTED ALLIED SUPPORT COURSES

The following list of allied support courses is recommended for students enrolling in an industrial mechanics cluster curriculum.

High school industrial arts programs provide many of the opportunities mentioned in the following course descriptions, although course titles may differ. Courses generally found in the high school curriculum (such as basic economics, speech, technical writing) can serve as support courses—electives. In most cases the existing program, with only slight content modification, will provide the experiences suggested in the following course descriptions. Students need to consider all available courses and discuss various alternatives with parents, school counselors, and industrial advisors. This added perspective can help students choose education programs more realistically.

Note: Participation in state and national skills contests helps build self-esteem, as well as to develop occupational skills.

### Basic Metalworking and Machine Tools

This course is designed to provide students with the fundamentals of basic metals and machine tools used in industry. Laboratory course work includes the theory and application of machine tools to forming and shaping of metals used to fabricate machine parts and assemble components. Students learn the basic operation of the drill presses, lathes, shapers, and grinders. Basic metallurgy can also be considered for discussion and experimentation.

### Welding Fundamentals

This is a lecture, demonstration, and laboratory course covering the fundamentals of oxyacetylene, electrical welding, soldering, and brazing of ferrous and nonferrous metals. Technical information is balanced with hands-on experience to provide an opportunity for the student to become familiar with methods in fabrications generally used in repair and maintenance.

### Graphic Communications

This course introduces students to graphic communications, i.e., the methods and mechanics used in modern industry to communicate ideas. Included are instruction and practice in principles of visualization, oral communication, technical sketching, basic drafting, blueprint reading, shop processes, specification and tolerancing, photography, and printing. Technical information is balanced with laboratory work to help students develop a fundamental understanding of technical communication on-the-job, i.e., schematic drawings, blueprints, technical service manuals, oral communications.

### Basic Electricity

This is a basic course in electrical fundamentals covering magnetism and electricity. Laboratory time involves demonstrations and experiments to help classify the principles of basic electricity, specifically Ohms Law. Emphasis is placed on the use and care of electrical machinery, especially

field anlaysis of electrical equipment failure and use of equipment, and electrical test devices to determine and make repairs on electric motors, switches, and transfer equipment.

Vocational Industrial Clubs of America

An integral part of the Industrial Mechanics Program, VICA activities are integrated into the curriculum to introduce students to leadership and social skills for mechanics operations. Although leadership skills vary with individual student needs, a planned program would involve instruction in customer relations, introducing people, conducting and participating in group meetings, planning activities, and speaking to groups of people.

## INDIVIDUALIZED INSTRUCTION

By its very nature, the cluster concept demands the use of some method of individualized instruction. No matter what method is used, it should be based on student performance that is measurable.

The use of an individualized learning system requires a reorientation of the instructor's role. The instructor becomes a counselor and a director to help guide the student through the system established by the instructor. The instructor answers questions on an individual basis, occasionally lectures to the whole class, or holds small-group seminars and discussions. Maintaining a record of the student's progress is also important.

An inservice program will be needed to orient instructors to their new roles and to the proper ways of implementing and directing individualized learning systems.

Any individualized system should be able to do the following:

Give credit for previously learned and demonstrated skills.

Allow students to pause for remedial assistance, and then resume their studies.

Inform each student of the specific behavioral outcomes for which that student will be responsible.

Allow the student to progress individually.

Monitor each student's progress.

## OREGON MANPOWER DATA

The following figures represent an analysis of Oregon manpower data for industrial mechanics occupations, around which curriculum was designed.

| Key Occupation For Analysis Process | Base Year 1976 | Current Employment 1980 | Future Need 1982 |
|---|---|---|---|
| *Refrigeration Mechanic | 220 | 250 | 260 |
| **Automotive Mechanic | 9,700 | 10,640 | 11,110 |
| *Aircraft Mechanic | 310 | 340 | 360 |
| *Office Machine Repairer | 590 | 650 | 670 |
| *Millwright | 400 | 440 | 460 |
| *Diesel Mechanic | 1,020 | 1,110 | 1,150 |
| *Small Engine or Mower Mechanic | 10 | 10 | 20 |
| ***All Other Mechanics | 2,690 | 2,980 | 3,120 |

*Figures shown are specific to the occupation listed.

**Includes automotive specialists.

***Other small engine mechanics (motorcycle, outboard, etc.) included here.

# INSTRUCTIONAL EMPHASIS AREAS

## INSTRUCTIONAL EMPHASIS AREAS

Listed below are the program goals around which chapters were organized:

The student will know techniques that promote safety consciousness on-the-job.

The student will be able to use standard industrial mechanics tools.

The student will be able to operate and service internal combustion engines.

The student will be able to select from a variety of available standard measuring tools used by industrial mechanics, and use these according to specific job needs.

The student will be able to operate standard machine tools used by industrial mechanics.

The student will be able to service electrical systems used by industrial mechanics and maintain these systems in working order.

The student will be able to operate and repair fluid power systems, and maintain these systems in working order.

The student will apply job-readiness skills.

The student will be able to operate, service and repair machines and equipment.

These goals parallel or go beyond the suggested goals for industrial mechanics occupations found in Elementary-Secondary Guide, Part II,* and are designed to provide the student learning opportunities to develop skills and knowledge in the key areas of industrial mechanics occupations.

Industrial mechanics is not synonymous with courses titled automotive mechanics, power mechanics or small engine mechanics. Such programs are specialized and limited in scope. Industrial mechanics offers the student a broad range of knowledge and skill development opportunities in the nine occupations that make up the cluster.

Graduates of a two-year industrial mechanics cluster program generally are not prepared for employment in any of the cluster occupations, but may seek employment as helpers or trainees in those cluster occupations offering apprenticeships, or they may elect to obtain further instruction in a community college or other post-secondary school.

In each of the emphasis areas which follow, suggested course goals, learning activities and performance indicators are given to assist the instructor in the development of a well-rounded industrial mechanics program.

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*Elementary-Secondary Guide For Oregon Schools, Part II: Suggestions* (Salem: Oregon Department of Education, 1977), p. 97.

# SAFETY

COURSE GOALS

The student will be able to:

inspect mechanics shops and recommend safety practices.

apply safety methods for machine and equipment operation.

use flammable liquids, caustic materials and cleaning equipment in a safe manner.

apply first aid.

COURSE GOAL:

The student will be able to inspect mechanics shops and recommend safety practices.

PERFORMANCE INDICATORS:

Given a safety inspection checklist covering facilities and equipment for a mechanics shop, the student will conduct an inspection, recommend needed improvements and declare acceptable those areas which meet the criteria for safety.

Given a series of bulk weight items generally found in a mechanics shop, the student will demonstrate safety approved lifting procedures for a variety of on-the-job situations.

SUGGESTED LEARNING ACTIVITIES:

Invite a safety inspector or an insurance investigator to class to discuss shop safety practices.

View safety films (SAIF, WEB, etc.)

Identify unsafe shop work habits and conditions.

Develop a student safety committee.

Conduct shop and equipment inspections.

Demonstrate correct lifting techniques.

Participate in state and national VICA safety programs and skills olympics.

Design and develop safety bulletin boards.

COURSE GOAL:

The student will be able to apply safety methods for machine and equipment operation.

PERFORMANCE INDICATORS:

Given class A, B, C, D fire extinguishers, the student will choose the recommended type and demonstrate its use with one or more classes of fire.

Given oily rags and a number of shop storage options, the student will demonstrate safe storage.

Given descriptions of typical hazardous conditions for industrial mechanics (chemicals, grinding, welding, etc.), the student will explain how to select, wear and maintain appropriate personal eye protection devices.

Given an automobile and a car hoist, the student will demonstrate approved safety procedures for use of the hoist.

Given an automobile and a five-ton hydraulic jack, the student will demonstrate the approved safety methods to use when one or more wheels of the auto are off the ground.

SUGGESTED LEARNING ACTIVITIES:

Inspect buildings for compliance with local safety codes for fire protection.

Inspect fire extinguishers for labels, tags, and charge.

Show films on fire fighting, classes of fire, and use of extinguishers.

Use manufacturer's manual for recommended procedures for operating jacks and hoists.

Practice safe methods of working on a raised vehicle.

COURSE GOAL:

The student will be able to use flammable liquids, caustic materials and cleaning equipment in a safe manner.

PERFORMANCE INDICATORS:

Given gasoline and solvents, the student will demonstrate safe storage and handling of these chemicals in the shop.

Given steam cleaners and parts washers, the student will demonstrate safe practices when using this equipment.

Given parts to be cleaned and compressed air, the student will demonstrate approved safety procedures for use of this equipment.

SUGGESTED LEARNING ACTIVITIES:

Review local and state regulations regarding inside storage of combustible materials.

Demonstrate cleaning with abrasives and chemical solutions.

Show films on the correct use of safety equipment and clothing.

Demonstrate proper storage of flammable and caustic materials in containers.

Demonstrate operation of steam cleaners and parts washers.

COURSE GOAL:

The student will be able to apply first aid skills.

PERFORMANCE INDICATORS:

Given first aid and safety equipment, the student will demonstrate skin care treatment and eye safety precautions when using caustic or combustible materials.

Given victims of a variety of hypothetical emergencies, the student will render first aid, call for help, and complete an accident report form.

Given a hypothetical situation in which a person is on fire, the student will demonstrate how to extinguish the fire, treat burns, and call the proper authorities to care for the victim.

SUGGESTED LEARNING ACTIVITIES:

Practice first aid for exposure of skin to acids and other caustic chemicals.

Show first aid films on treatments for a number of accidents.

Practice first aid treatment for shock, external bleeding, burns, broken bones, mouth-to-mouth resuscitation and CPR.

Participate in VICA safety program.

# BASIC MECHANICAL SKILLS

COURSE GOALS

The student will be able to:

identify and use hand tools.

identify and use power tools.

use soldering equipment.

use welding equipment.

read schematic drawing and blueprints.

add, subtract, multiply and divide whole numbers, decimals and fractions.

give and follow directions.

COURSE GOAL:

The student will be able to identify and use hand tools.

PERFORMANCE INDICATORS:

Given a variety of mechanics tools (wrenches, hammers, screw drivers, pliers, chisels), the student will identify them by proper and standard names and demonstrate their uses.

Given 6, 8 and 12 point sockets with ratchets and breaker bars, the student will demonstrate their correct uses.

Given a tap and die set and specified dimensions, the student will demonstrate how to select and use a standard tap and die set by tapping and chasing a thread.

Given a hand file and hacksaw, the student will cut, deburr, and square the cut end of a piece of steel bar stock.

Given a variety of mechanic tools, the student will identify those that are unsafe for use, and will recondition for return to service, or discard.

SUGGESTED LEARNING ACTIVITIES:

Use tool identification catalogs to identify, order and price a basic mechanics tool set.

Have students visit shops and collect names and terms commonly used to identify mechanics tools and equipment.

Use standard reference texts to review and demonstrate techniques for hand tool use.

Disassemble and assemble parts using socket sets, wrenches and other tools.

Using a hacksaw, cut a piece of metal exactly 2" x 2". Use a tap chart and drill and tap 5/16" USS threads in a through or blind hole.

Deburr and square a piece of metal stock with single and double cut files.

Recondition a standard screwdriver, cold chisel, center punch, drill bit and gasket scraper.

COURSE GOAL:

The student will be able to identify and use power tools.

PERFORMANCE INDICATORS:

Given a disc grinder, the student will demonstrate how to properly operate it on flat iron plate to smooth, or remove oxides.

Given a valve refacer and one exhaust and one intake valve, the student will demonstrate how to properly operate the refacer by resurfacing the valves.

Given a valve seat resurfacing kit, the student will demonstrate how to properly operate it by resurfacing two valve seats.

Given material needing to be ground or wire brushed, the student will safely use a bench grinder to grind and brush.

SUGGESTED LEARNING ACTIVITIES:

Read manufacturers' operator manuals for all power tools and pieces of equipment found in the shop.

Check manufacturers' specifications for tolerances when reconditioning parts.

Use appropriate safety precautions when operating power tools.

View films on power tool use.

Identify the parts of power tools using appropriate terminology.

Check tools for proper operation.

Stucy maintenance procedures for power tools.

Demonstrate proper and safe use of electric and air operated hammers, wrenches and cutters.

The student will be able to use soldering equipment.

## PERFORMANCE INDICATORS:

Given flame, iron, and gun soldering equipment, the student will know where each should be used.

Given iron and gun soldering equipment, tinning chemicals and solder, the student will clean and tin the soldering tips.

Given metal, wire brush, and cleaning compounds, the student will clean and prepare metal for soldering.

Given a soldering iron, chemical cleaning compounds, thin metal, and acid-core solder, the student will sweat-a-patch, solder a seam, and repair small holes.

Given a soldering gun, solder, electrical wire and fittings, the student will correctly solder the fittings to the wire.

## SUGGESTED LEARNING ACTIVITIES:

View films showing soldering techniques.

Observe soldering demonstration.

Practice soldering wire splices, soldering cable connectors, diodes, resistors, and similar units into proper location.

Recondition soldering tip and re-tin.

Visit an electronics assembly plant.

COURSE GOAL:

The student will be able to use welding equipment.

PERFORMANCE INDICATORS:

Given gas and arc welding equipment, the student will demonstrate safe methods of use.

Given several welding jobs, the student will select whether gas or arc welding should be used and give reasons why.

Given metal samples of varying thickness and composition, the student will select approximate amperage settings for each.

Given proper equipment and a series of welding tasks standard for industrial mechanics, the student will perform a series of welds to the instructor's satisfaction.

SUGGESTED LEARNING ACTIVITIES:

Demonstrate metal identification and spark-testing procedures.

Observe welding demonstrations.

Visit a welding or metal fabrication plant.

Show films on gas and arc welding procedures.

Obtain scrap parts to practice removing nuts, studs, bearing races, etc.

Study electrode charts and oxyacetylene charts.

COURSE GOAL:

The student will be able to read schematic drawings and blueprints.

PERFORMANCE INDICATORS:

Given a series of blueprint drawings, the student will identify the subject of each drawing.

SUGGESTED LEARNING ACTIVITIES:

Show films on blueprints.

Conduct a class in basic blueprint reading.

Have students develop blueprint vocabularies.

Have students visit a drafting class.

Have students draw some basic automotive and mechanical parts and systems (e.g., spark plugs and bearings) naming the functions and materials used.

COURSE GOAL:

The student will be able to add, subtract, multiply and divide whole numbers, do fractions and decimals.

PERFORMANCE INDICATORS:

Given a list of parts for a particular repair job, and the labor costs, the student will calculate the total cost of the repair in writing.

Given a series of arithmetic problems containing whole numbers, fractions and decimals, the student will demonstrate acceptable math skills in writing.

Given an outside micrometer and worn as well as new parts, the student will demonstrate the ability to compute decimals through measurement and comparison.

SUGGESTED LEARNING ACTIVITIES:

Use a flat-rate manual to calculate parts and labor for a shop repair job.

Multiply head bolt torque times lever arm to determine total force.

Use formula I=E/R to determine current flow to a 4 ohm resistance with 12 DC volts applied.

Calculate weekly wages using a commission, parts and labor formula.

Develop work order estimates.

COURSE GOAL:

The student will be able to give and follow directions.

PERFORMANCE INDICATORS:

Given a list of shop rules and regulations, the student will read, interpret and follow directions.

Given a piece of equipment, the student will give oral and written directions as to its use.

Given a piece of equipment needing repair and a repair kit with instructions, the student will complete the repair to the instructor's approval.

Given a particular shop task, the student will direct another student in completing it satisfactorily.

SUGGESTED LEARNING ACTIVITIES:

Describe and demonstrate nonverbal communication techniques.

Discuss signals and safety in industrial occupations.

Conduct a local shop VICA skills contest using student judges.

Interview policemen, firemen, and businessmen who rely on and must give clear directions.

# MECHANICAL MAINTENANCE

COURSE GOALS

The student will be able to:

explain the internal combustion engine in writing.

start and operate two and four stroke cycle engines.

use a mechanic's stethoscope to identify sounds in operating equipment.

clean mechanical, electrical and fluid power parts with available cleaning equipment.

COURSE GOAL:

The student will be able to explain the internal combustion engine in writing.

PERFORMANCE INDICATORS:

Given descriptions of internal combustion engines, the student will classify them by: (1) fuels burned, (2) valve arrangement, (3) cylinder arrangement, (4) type of cooling system, (5) number of strokes-per-cycle, (6) piston displacement.

Given engines and reference materials, the student will identify components and their functions in the following systems: (1) fuel, (2) lubricating, (3) cooling, (4) ignition, (5) valve train, (6) crankshaft-bearings-pistons, (7) cylinder block assembly, (8) starting, (9) charging.

Given parts catalogs and an engine with defective parts, the student will order replacement parts.

Given a cutaway engine or disassembled engine parts, the student will identify all short-block parts and their functions.

SUGGESTED LEARNING ACTIVITIES:

Organize field trips to local garages, engine rebuilding shops, and auto recyclers.

Remove or replace, assemble or disassemble engines and accessories.

Show films on engine description and classification.

Demonstrate how to fill out an order for a replacement part.

COURSE GOAL:

The student will be able to start and operate two and four stroke cycle engines.

PERFORMANCE INDICATORS:

The student will list in writing fuel hazards, electrical hazards, and poisonous gas hazards of internal combustion engines.

Given two and four stroke cycle engines, the student will demonstrate acceptable starting procedures.

Given a list of engine starting problems, the student will briefly describe how each is diagnosed and serviced.

Given a gasoline engine, the student will start and operate the engine making necessary adjustments for proper operation.

Given a diesel engine, chainsaw, and an outboard engine, the student will start, operate and adjust engine rpm to manufacturers' specifications.



SUGGESTED LEARNING ACTIVITIES:

Observe demonstrations of starting procedures and the operation of internal combustion engines. Discuss engine emissions and causes.

Discuss safety factors involved when operating engines in confined spaces.

Show films on engine operation and safety.

Explain the effects of weather conditions on engine starting and performance.

Review engine adjustments, e.g., choke, idle, etc.

COURSE GOAL:

The student will be able to use a mechanics stethoscope to identify sounds in operating equipment.

PERFORMANCE INDICATORS:

Given a mechanics stethoscope and various operating machines, the student will listen for and identify specific sounds.

SUGGESTED LEARNING ACTIVITIES:

Listen to shafts turning in bushings, ball and roller bearings, gear boxes, fuel pumps, etc.

Listen to electric motors, automobile engine, washing machine, alternators, fans, etc.

Identify sounds made by various materials coming into contact with each other, such as tempered steel and untempered steel, nonmetallic and metallic materials, etc.

Help students develop techniques to determine distance and direction of sounds.

COURSE GOAL:

**The student will be able to select cleaning equipment and clean mechanical, electrical and fluid power parts.**

PERFORMANCE INDICATORS:

Given several types of cleaning solutions, the student will indicate where each should be used.

The student will list in writing safety procedures to use when cleaning parts with steam, abrasives, spray guns, or air pressure.

Given the following cleaning equipment and parts to be cleaned, the student will select the proper equipment for the part and demonstrate its use:

- scrapers
- glass bead
- hot tank
- cold tank
- wire brush
- parts washer
- ultrasonic
- steam cleaner
- low pressure spray gun

SUGGESTED LEARNING ACTIVITIES:

Show film demonstrations of various cleaning techniques.

Visit repair shops and observe cleaning techniques and methods.

Survey consumer products designed for cleaning parts and equipment.

Demonstrate efficient procedures for a number of cleaning agents.

# MEASUREMENT

COURSE GOALS

The student will be able to:

select from a variety of available calipers, and use these according to specific job needs.

use dial indicators.

use feeler gauges.

use steel rules and tapes.

use a thread pitch gauge.

use plug gauges.

use hydrometers.

select from a variety of available thermometers, and use these according to specific job needs.

select from a variety of available tachometers, and use these according to specific job needs.

read pressure and vacuum gauges.

use an oscilloscope and an exhaust gas analyzer.

use a torque wrench.

COURSE GOAL:

The student will be able to select from a variety of available calipers, and use these according to specific job needs.

PERFORMANCE INDICATORS:

Given several types of calipers and micrometers, the student will identify each and where it is properly used.

Given calipers, steel rules and machine parts, the student will demonstrate handling and manipulative techniques while taking and recording measurements.

Given a micrometer and machine parts, the student will take measurements to within ± .001 inches, and ± .01 millimeters.

Given micrometers, the student will demonstrate proper handling and storage of the instruments in the shop.

SUGGESTED LEARNING ACTIVITIES:

Observe a demonstration of caliper use techniques.

Read reference materials on the care and use of calipers.

Show films on the use of calipers and micrometers.

Demonstrate handling techniques for calipers and micrometers.

Demonstrate measurement techniques for feeler gauges, shafts, cylinders, pistons.

Participate in VICA activities.

COURSE GOAL:

The student will be able to use dial indicators.

PERFORMANCE INDICATORS:

Given several types of dial indicators, the student will identify each by its standard name and specific area of use.

Given a dial indicator, base, and V-block, the student will demonstrate techniques for measuring play in shafts, backlash in gear teeth, valve lift, and taper in cylinders.

Given dial indicators and mechanical equipment, the student will measure, record, and interpret wear patterns.

SUGGESTED LEARNING ACTIVITIES:

Measure cylinders for out-of-round and taper.

Use cutaway of differential assembly to measure ring gear backlash, and runout.

Arrange camshaft and V-blocks to measure bearing surface runout, and cam wear.

COURSE GOAL:

The student will be able to use feeler gauges.

PERFORMANCE INDICATORS:

Given spark plugs and feeler gauges, the student will select the proper gauge and adjust electrode clearance to instructor's specifications.

Given a set of feeler gauges and a variety of operating mechanical devices, the student will measure and record clearances to .001 inches and .01 millimeters.

SUGGESTED LEARNING ACTIVITIES:

Demonstrate adjusting spark plug electrode gap with round feeler gauges.

Show films on the feeler gauge and its proper use.

Have students practice adjusting point gap, measuring gear pump clearances, piston to cylinder wall clearance, valve tappet clearance.

Demonstrate using a feeler gauge with straight edge to measure warpage.

Participate in VICA activities.

COURSE GOAL:

The student will be able to use steel rules and tapes.

PERFORMANCE INDICATORS:

Given rules graduated in 8ths, 12ths, 32nds and 64ths of an and a variety of items to measure, the student will make, record and convert readings to decimal equivalents.

Given rules and tapes graduated in English and metric units, the student will make and record linear measurements.

SUGGESTED LEARNING ACTIVITIES:

Compare units of length, area, weight and volume using English and metric units.

Measure bore and stroke of an engine in millimeters and inches.

Measure lengths of hose, shaft, tubing, etc., in millimeters and inches.

Participate in VICA activities.

COURSE GOAL:

The student will be able to use a thread pitch gauge.

PERFORMANCE INDICATORS:

Given thread pitch gauges and threaded machine parts, graduated both in English and metric units, the student will measure threads-per-inch, or thread pitch.

Given UNC, UNF, ISO and UNEF threaded stock and thread pitch gauges, the student will determine threads-per-inch and convert to decimal equivalents.

SUGGESTED LEARNING ACTIVITIES:

Demonstrate how to determine thread pitch.

Disassemble parts using threaded fasteners that have different thread pitch. Explain the differences among and advantages of UNC, UNF, ISO and UNEF threads, application of use and why one is used instead of another.

COURSE GOAL:

The student will be able to use plug gauges.

PERFORMANCE INDICATORS:

Given plain-cylindrical plug gauges and mechanical parts, the student will demonstrate gauge use.

Given cylindrical-taper plug gauges and machines, the student will demonstrate gauge use.

SUGGESTED LEARNING ACTIVITIES:

Measure carburetor jet openings, etc.

Measure taper of machine tool spindles, and various kinds of tool adaptors.

COURSE GOAL:

The student will be able to use hydrometers.

PERFORMANCE INDICATORS:

Given hydrometers, batteries and an operating cooling system filled with antifreeze solution, the student will demonstrate hydrometer use.

Given a temperature correction chart, the student will compute temperature corrections for battery and antifreeze readings.

SUGGESTED LEARNING ACTIVITIES:

Measure specific gravity of a cold and hot acid-water solution (use 12 volt auto battery).

Measure specific gravity of hot and cold antifreeze solutions.

Demonstrate how temperature affects meter reading.

COURSE GOAL:

The student will be able to select from a variety of available thermometers, and use these according to specific job needs.

PERFORMANCE INDICATORS:

Given thermometers which employ both English and metric units, the student will demonstrate how they are used to test operating machines and equipment.

Given reference texts and operator's manuals, the student will locate and then record in writing recommended operating temperatures for machines and equipment.

Given the proper equipment, the student will demonstrate how a cooling system thermostat is tested for proper operation.

SUGGESTED LEARNING ACTIVITIES:

Measure evaporator air-in and air-out temperatures.

Measure condenser air-in, air-out temperatures.

Measure cooling system operating temperatures for liquid and air cooled engines.

Discuss temperature and mechanical equipment operating efficiency.

Measure crankcase oil temperatures, and compare to cooling system and engine block temperatures.

Measure automatic transmission oil temperature compared to cooling system temperature.

COURSE GOAL:

The student will be able to select from a variety of available tachometers, and use these according to specific job needs.

PERFORMANCE INDICATORS:

Given tachometers, the student will demonstrate how each is used to measure rotative speeds.

Given a tachometer and an operating mechanical system, the student will measure and adjust rpm to specification.

Given a tachometer, test leads and instructions, the student will calibrate the instrument.

SUGGESTED LEARNING ACTIVITIES:

Measure shaft rotative speed (clockwise and counterclockwise rotation).

Examine data plate of machine for recommended rpm (electric motors, auto engines).

Study specification charts for information about rpm under varying conditions (hot and cold settings, summer and winter settings).

Test and adjust fast-idle and curb-idle speeds for an internal combustion engine.

Test hydraulic pump rpm and compare to pump capacity and system actuator speeds.

COURSE GOAL:

The student will be able to read pressure and vacuum gauges.

PERFORMANCE INDICATORS:

Given pressure gauges and operating mechanical systems, the student will demonstrate how each gauge is used to test the systems.

Given specification charts, test instruments and operating systems, the student will test the systems and record data in writing.

Given a vacuum gauge and operating systems, the student will demonstrate how vacuum tests are made.

Given a vacuum gauge, specification chart and designated systems, the student will test the systems and record gauge readings in writing.

SUGGESTED LEARNING ACTIVITIES:

Measure compression pressure for an internal combustion engine.

Measure fuel pump pressure.

Measure fuel pump vacuum.

Measure high and low-side pressures for an automobile air-conditioning system.

Measure cooling system pressure at the radiator.

Measure intake manifold vacuum for an internal combustion engine.

Evacuate a refrigeration system using a vacuum pump and gauge.

Measure the vacuum necessary to activate a vacuum valve in a radiator cap.

COURSE GOAL:

**The student will be able to use an oscilloscope and an exhaust gas analyzer.**

PERFORMANCE INDICATORS:

Given an oscilloscope, operator's manuals and an internal combustion engine, the student will demonstrate proper hookup procedure and identify the following waveforms:

- sparkplug firing voltage/firing order
- ignition coil action
- breaker point action
- ignition coil available voltage
- reversed coil polarity
- excessive secondary circuit resistance
- distributor point dwell
- condenser action
- insulation leakage
- excessive rotor gap

Given an oscilloscope and an automobile engine needing ignition system repair, the student will measure, test and troubleshoot the ignition system and make necessary adjustments to restore the system to proper working order.

Given an exhaust gas analyzer and an automobile, the student will measure hydrocarbon (HC) and carbon monoxide (CO) emissions.

Given an exhaust gas analyzer and internal combustion engine, the student will test for malfunctioning fuel and ignition systems.

SUGGESTED LEARNING ACTIVITIES:

Observe demonstration of oscilloscope use.

Visit an auto service shop; talk to a mechanic about oscilloscope use.

Interpret kilovolt scale on an oscilloscope screen.

Draw and label primary and secondary waveforms.

Place defective parts in ignition system to observe change in waveform.

Use exhaust gas a[illegible] and note effect of a misfiring cylinder, leaky gasket, etc.

Adjust fuel-air mixture of an engine and measure the varying readings on a CO meter.

Participate in VICA activities.

COURSE GOAL:

The student will be able to use a torque wrench.

PERFORMANCE INDICATORS:

Given torque wrenches graduated in foot and inch pounds, and several pieces of equipment with bolts to be tightened to specific torques, the student will select the proper torque wrench and tighten the bolts to the required specifications.

SUGGESTED LEARNING ACTIVITIES:

Explain the difference between inch and foot pounds.

Demonstrate the proper use of torque wrenches.

Have students tighten bolts and nuts with both inch and foot pound torque wrenches.

Show movies on stress and torque.

# MACHINE TOOLS

COURSE GOALS

The student will be able to:

operate a drill press.

operate a machine lathe.

operate a pedestal grinder.

operate a power hacksaw.

COURSE GOAL:

The student will be able to operate a drill press.

PERFORMANCE INDICATORS:

Given a floor or bench model drill press, the student will identify the working parts.

Given vises and clamps, the student will demonstrate three methods of holding work for drilling.

Given several pieces and thicknesses of metal for drilling, the student will test each metal for hardness and identify the machinability of each.

Given a drill press, centerpunch, drills, countersink, hardware, and metal, the student will drill and countersink holes.

Given necessary tools, equipment and hardware, the student will drill and counterbore to fit a fillister-head screw.

Given necessary tools and equipment, the student will spotface cast on to fit a cap screw.

SUGGESTED LEARNING ACTIVITIES:

Review instructions for machine operation.

Demonstrate drilling techniques for a variety and thickness of metals.

Show how to test metal for hardness using a file.

Observe a demonstration of a drill press in operation.

Have students choose and use cutting speeds that are standard for the drill sizes and materials involved.

Have students sharpen twist drills, measure and compare hole sizes to drill sizes, and determine the causes of oversized holes.

Demonstrate how to use a twist drill to drill a hole for the removal of a broken stud.

Use a tachometer to determine drill press spindle speeds and compare actual speeds to indicated speeds.

COURSE GOAL:

The student will be able to operate a lathe.

PERFORMANCE INDICATORS:

Given a lathe and operator's manual, the student will identify the working parts of the lathe.

Given a lathe, the student will demonstrate a number of operations including: adjustment of spindle speeds, back gear, forward and reverse automatic feed, and safety precautions for machine operation.

Given metal, tools, and equipment, the student will prepare metal and complete the following operations:

- Face-off stock.
- Prepare metal for turning between centers.
- Turn metal until it is concentric.

Given a lathe, the student will demonstrate proper procedures for cleaning and servicing.

SUGGESTED LEARNING ACTIVITIES:

Study machine operator's handbook.

Visit a local machine shop.

Observe a demonstration of a lathe.

Test metal for hardness before submitting it to machine operations.

Show films of lathe operation.

Turn a commutator; true a shaft.

COURSE GOAL:

The student will be able to operate a pedestal grinder.

PERFORMANCE INDICATORS:

Given a bench or pedestal grinder, the student will examine the grinder for safety washers, explosion guards, and properly adjusted tool rest and tongue.

Given a grinding wheel and a motor, the student will test the wheels for maximum rpm, soundness, chips and cracks, and will check the grinder data plate for rpm specifications.

Given round and flat mild steel stock, the student will select the proper wheel and grind the ends of each to square with their lengths.

Given a dressing tool and a grinder with wheel, the student will dress the wheel, eliminating out-of-round, loading and glazing.

Given a pedestal grinder and a piece of metal to be ground, the student will adjust the tongue and tool rest to 1/8" of the wheel and will demonstrate the safe and approved method for grinding.

SUGGESTED LEARNING ACTIVITIES:

Invite a safety expert to speak to the class.

Demonstrate how to adjust tool rest and tongue to 1/8" of wheel.

Show films on the proper use of a grinder.

Demonstrate how to dress a grinding wheel.

COURSE GOAL:

The student will be able to operate a power hacksaw.

PERFORMANCE INDICATORS:

Given a power hacksaw, the student will demonstrate adjustment and safe operation procedures.

Given various shapes and lengths of metal, and a hacksaw, the student will cut the metal to exact lengths.

Given a power hacksaw with an adjustable vise, and various shapes of metal, the student will cut the metal to specified angles and lengths.

Given a power hacksaw, the student will demonstrate how to clean and service the machine.

SUGGESTED LEARNING ACTIVITIES:

Use operator's handbook for operating instructions.

Observe a demonstration of power hacksaw operation.

Observe operation of wet and dry machines.

Explain blade selection, cutting speeds, use of coolant.

# MECHANICAL SYSTEMS

COURSE GOALS

The student will be able to:

apply basic procedures for shafts and seals to specific job needs.

select bearings from a variety of available bearings according to specific job needs, and service all types of bearings.

service couplings and clutches, and maintain couplings and clutches in working order.

select from a variety of available fuels, lubricants, coolants and filters, and use these appropriately according to specific job needs.

service gear mechanisms and maintain them in working order.

service belt and chain drive mechanisms.

COURSE GOAL:

**The student will be able to apply basic procedures for shafts and seals to specific job needs.**

PERFORMANCE INDICATORS:

Given solid, hollow, keyed, and splined shafts, the student will identify where each is used.

Given a variety of seals, the student will identify the material used in construction, and indicate where and why each is used.

Given a shaft and seal assembly, the student will remove and replace a seal using appropriate tools.

Given an engine block with crankshaft installed, the student will remove the shaft, remove and replace shaft seals, and install the crankshaft in the block.

Given a driveshaft from a gear box, pump or business machine, the student will identify shaft parts, and list their functions in writing.

Given a variety of shafts, the student will inspect them for trueness, smoothness of journals, damaged splines, and damaged seal areas.

Given the input and output shaft on a gear box, pump, compressor, or similar machine, the student will remove and replace the shafts and seals using appropriate tools.

SUGGESTED LEARNING ACTIVITIES:

Examine shop equipment and other machines for shaft arrangements.

Examine seal structure; relate structure, function, and seal materials to use.

Consult shop manuals for service procedures.

Remove and replace a variety of shafts with bearings and seals.

Write manufacturers of shafts and seals for service information.

Visit a local repair shop to observe a mechanic remove and replace shafts and seals.

Obtain several different shafts and seals and explain their uses and differences to the class.

Practice straightening bent shafts: camshafts, crankshafts, generator/alternator shafts.

Participate in VICA activities.

COURSE GOAL:

The student will be able to select bearings from a variety of available bearings according to specific job needs, and service all types of bearings.

PERFORMANCE INDICATORS:

Given open ball and roller bearings, the student will clean the bearings with solvent, and dry and repack the bearings with the proper lubricant.

Given friction and anti-friction bearings, the student will list in writing the advantages and disadvantages of each type.

Given a variety of bearings, the student will inspect for various bearing problems, recording damage for each in writing.

Given friction bearings, shafts, and proper tools, the student will fit the bearings to the shafts and measure bearing clearance.

Given a variety of bearings, the student will identify, by type, the metal used in construction, and standard use of each.

SUGGESTED LEARNING ACTIVITIES:

Remove, clean and inspect a variety of bearings: roller, needle, ball, sintered bronze.

Show industry films to demonstrate various methods for lubricating bearings on machines.

Review causes and remedies for bearing failure.

Use micrometer, telescoping and expansion gauges and plasti-gauge to measure bearing clearances.

Identify types of bearing materials used on marine applications, office equipment, low and high temperature, as well as low and high speed applications.

Discuss bearing construction, properties of metals used and special bearing applications.

Discuss the theories behind using specific types of bearings.

COURSE GOAL:

The student will be able to service couplings and clutches, and maintain couplings and clutches in working order.

PERFORMANCE INDICATORS:

Given a power plant with clutch assembly attached, the student will remove the clutch assembly and identify each part and its function.

Given a disassembled clutch, the student will inspect parts for wear, determine serviceability, and reassemble the clutch.

Given an assembled clutch, the student will align and replace the clutch assembly according to manufacturer's recommended procedures, and adjust clutch linkage.

Given rigid, flexible, universal, and torque amplifying couplings, the student will list in writing the operating principles of each.

Using disc-type, band-type, overrunning-type, and expanding-shoe-type clutches, the student will list in writing the advantages and disadvantages of each.

Given examples of mechanically, hydraulically, and electrically operating clutch mechanisms, the student will outline in writing the operating principles of each.

SUGGESTED LEARNING ACTIVITIES:

Remove, inspect, service and replace clutch assemblies on motorcycles, agricultural equipment, business machines, recreational vehicles, washing machines, and automobiles with standard transmissions.

Discuss wear and operation of:

- splines
- pilot bearings
- friction surfaces
- throw-out bearings
- contact surface runout.

Demonstrate preventative maintenance for a fluid coupling using a car or motorcycle with an automatic transmission.

Remove and replace a universal joint.

Compare automobile clutch operation with that of an electric typewriter or piece of agricultural equipment.

Remove and replace a clutch assembly from any machine other than an automobile.

COURSE GOAL:

**The student will be able to select from a variety of fuels, lubricants, coolants and filters, and use these appropriately according to specific job needs.**

PERFORMANCE INDICATORS:

Given samples of LPG, gasoline and diesel fuels, the student will list in writing the characteristics of each, as well as those characteristics in common, and indicate according to engine compressions where each should be used.

Given samples of engine oils, gear oils, hydraulic and transmission fluids and lubricating greases, the student will list the characteristics and standard uses of each.

Given alcohol based solutions and ethylene glycol base antifreeze, the student will test each solution using a hydrometer to measure and record protection against freezing.

Given lubricating dispensing equipment and lubricating grease, the student will perform periodic lubrication service on a machine or piece of equipment.

Given a liquid cooling system, the student will drain, flush and fill the system with the recommended coolant.

Given a filtered system, oil or water, the student will remove the filter, inspect it for contamination and install a new filter of the proper type.

Given different types of filters, the student will identify materials used in construction, and will classify the filters as to high or low quality.

SUGGESTED LEARNING ACTIVITIES:

Show industry films on the manufacture of oils, fuels, coolants and lubricants.

Discuss API (American Petroleum Institute) service ratings for engine oils.

Discuss lubricant viscosity numbers and their application.

Review fuel octane and cetane numbers.

Discuss the use of lubrication charts and service manuals in servicing procedures.

Disassemble High and Low quality filters and compare.

Discuss and demonstrate the pros and cons of additives for fuels, oil and coolants.

Demonstrate testing fuels, lubricants, coolants for contamination.

## COURSE GOAL:

The student will be able to service gear mechanisms and maintain them in working order.

## PERFORMANCE INDICATORS:

Given spur, bevel, helical, hypoid and herringbone gears, the student will identify each type and show how each is used.

Given gears, gear patterns and technical diagrams, the student will assemble the gears into the patterns.

Using a gear box and pattern dye, the student will demonstrate backlash, preload, gear patterns, and runout.

Given used gears, magniflux or penetrant dye, the student will inspect parts for cause(s) of failure.

Given a planetary gear arrangement, the student will demonstrate power flow for: gear reductions, power increase, and reverse rotation.

## SUGGESTED LEARNING ACTIVITIES:

Review reference texts and charts to identify gears and their uses.

Study simple and compound gear trains.

Take a field trip to a transmission rebuild shop.

Examine parts that have failed in gear trains.

Study gear pattern charts.

Use service manuals for suggested repair procedures.

Study the availability and need for different gear lubricants.

Have students apply servicing techniques on different types of gear box mechanisms (e.g., motorcycle, outboard engine, agriculture equipment, business machine, washing machine, auto or industrial equipment).

COURSE GOAL:

The student will be able to service belt and chain drive mechanisms.

PERFORMANCE INDICATORS:

Given belt applications and a number of flat, V-section, ribbed and round belts, the student will know the uses of each.

Given belt drive equipment and tools, the student will remove, inspect, replace, adjust and align belts and pulleys.

Given a number of used and damaged belts, the student will identify belt damage and determine the serviceability of each.

Given chain applications and lengths of roller, silent, offset and pintle chain, the student will know the use of each.

Given chain driven equipment and tools, the student will remove, repair, replace and adjust chains and sprockets.

Given a power chain driven machine needing service, the student will remove, clean, inspect, service, install, adjust and operationally test the chain drive mechanism.

SUGGESTED LEARNING ACTIVITIES:

Remove, inspect, service and replace pulleys and belts on chain saws, motor bikes and office machines.

Review service manuals for belt servicing procedures.

Measure belt sizes using appropriate measuring instruments.

Adjust belt tension using proper tools and equipment. Demonstrate the consequences of over/under tension adjustments.

Demonstrate installation of pulleys and alignment procedures for proper belt operation.

Demonstrate how to determine shaft output speed and power using both mathematical calculations and tachometers.

# ELECTRICAL SYSTEMS

COURSE GOALS

The student will be able to:

identify and use standard electrical symbols.

compute formulas using Ohm's Law.

explain and arrange electrical circuits.

explain electrical power generation in writing.

use volt, amperage and resistance measuring instruments.

test electrical devices.

test and install standard solid state devices.

service and install lead acid batteries.

service and repair electrical motors.

use a dwellmeter.

COURSE GOAL:

The student will be able to identify and use standard electrical symbols.

PERFORMANCE INDICATORS:

Given schematic drawings of electrical circuits, the student will identify and sketch the following symbols:

- Alternator
- Lamp (light)
- Transformer
- Resistor
- Capacitor
- Battery
- Ground
- Switch
- Meters
- Coil
- SCR (silicon controlled rectifier)
- Diode
- Transistor
- Relay
- Fuse

SUGGESTED LEARNING ACTIVITIES:

Use manuals to identify electrical symbols.

Read schematics and identify system components.

Sketch a basic electrical circuit using symbols, build the circuit, and test the circuit for proper operation using manufacturers' specifications.

Using an electrical schematic of an auto, appliance, agricultural or industrial equipment, business machine or recreational device, demonstrate how to locate select electrical equipment, switches, devices, coded wires, etc.

COURSE GOAL:

The student will be able to compute formulas using Ohm's Law.

PERFORMANCE INDICATORS:

Given the mathematical formula for Ohm's Law, the student will apply the formula, so that when two factors are known, the third can be calculated.

Given meters and operating electrical circuits, the student will measure voltage, amperage, and resistance; then calculate each using the Ohm's formula.

Given various electrical components, and using Ohm's formula, the student will calculate the wattage of each.

SUGGESTED LEARNING ACTIVITIES:

Read about Ohm's Law.

Arrange a single circuit consisting of battery, wire and a bulb on which to make measurement.

Work practical problems using Ohm's formula.

Use an electrical coil or field winding, battery, proper meters, etc., to calculate amp load, voltage and resistance. Compare the results mathematically with standard specifications.

COURSE GOAL:

The student will be able to explain and arrange electrical circuits.

PERFORMANCE INDICATORS:

The student will draw series, parallel, and series-parallel circuits which meet instructor approval.

Given a power source, conductors and electrical components, the student will arrange circuits and explain their operation in terms of amperage, voltage, and resistance.

SUGGESTED LEARNING ACTIVITIES:

Identify operational series, parallel, and series-parallel circuits.

Demonstrate voltage changes between series and parallel circuits using batteries and resistors.

COURSE GOAL:

The student will be able to explain electrical power generation in writing.

PERFORMANCE INDICATORS:

Given a small horseshoe magnet, wire coil and low voltage lamp, the student will demonstrate how electrical energy is generated.

Given a small alternator, the student will explain how it produces electrical energy.

Given a portable power generating plant, the student will place a function load to use and measure power output.

SUGGESTED LEARNING ACTIVITIES:

View films about power generating systems.

Visit a power generation plant, dam, etc.

Discuss safety measures in the distribution and use of electricity.

Set up an alternator and measure its total output.

With a 1500 watt or similar power generating plant, trace power flow; put power source to a specific use and measure output.

Use a battery charger to demonstrate conversion of AC to DC, and test step-down (or step-up) transformers.

COURSE GOAL:

The student will be able to use volt, amperage and resistance measuring instruments.

PERFORMANCE INDICATORS:

Given an ohmmeter, lengths of ignition wire, coils, relays, solenoids, and other components, the student will measure and record resistance against specifications.

Given AC and DC ampmeters, electrical motors and appliances, the student will measure and record starting and operating amperage.

Supplied with AC and DC voltmeters, and AC and DC circuits, the student will measure and record meter readings.

Given a DC circuit and a voltmeter, the student will identify voltage drop throughout the total circuit and across each circuit component.

Given an electrical component or schematic of an electrical circuit, the student will identify the continuity of the component or circuit.

SUGGESTED LEARNING ACTIVITIES:

Demonstrate how to measure: resistance of an ignition resistor, length of copper wire, length of aluminum wire, length of tungsten or polychrome wire; primary ignition coil winding, light bulb element and heating element winding.

Measure amperage demand of electric motors, steam irons, toasters, automobile starting motors, and light bulbs.

Measure automobile voltage drop when starting, ignition coil voltage, open circuit voltage of arc welders, automobile alternator charging voltage, etc.

Measure voltage drop across an electrical connection, such as at the battery post of an automobile.

Using an AC or DC electrical circuit with no ground, demonstrate how to identify and repair the problem using proper techniques and tools.

Participate in VICA activities.

COURSE GOAL:

The student will be able to test electrical devices.

PERFORMANCE INDICATORS:

Given an induction coil, a battery, switch, capacitor, and wire, the student will demonstrate coil, capacitor and switch functions.

Given a coil, capacitor, and test equipment, the student will determine the operating condition of the coil and capacitor.

Given a magneto operated engine, test equipment, and tools, the student will disassemble, test, adjust and reassemble the system.

Given an operating electrical system, the student will demonstrate the proper removal and replacement of the coil, capacitor and distributor.

SUGGESTED LEARNING ACTIVITIES:

Arrange an engine ignition system, light switch, charging system, starting system, windshield wiper circuit or other electrical circuit on a mockup panel.

Discuss and demonstrate equipment used for testing electrical circuits.

Study repair manuals for disassembly and assembly techniques for electrical system components.

Test induction coils for correct and reverse polarity.

Test such electrical devices as relays, switches, solenoids, etc., for high resistance or voltage drop.

Demonstrate how to locate an "open" short or ground in an electrical circuit.

COURSE GOAL:

The student will be able to test and install standard solid state devices.

PERFORMANCE INDICATORS:

Given a diode and test equipment, the student will demonstrate diode testing.

Given a light emitting diode, pressing and soldering equipment, the student will correctly install the diode.

Given a battery, resistor, SCR (silicon-controlled rectifier), buzzer, switches, and wire, the student will arrange a circuit to demonstrate SCR function.

Given resistors and testing equipment, the student will inspect and test them for usability.

SUGGESTED LEARNING ACTIVITIES:

Study diode, transistor, and SCR principles.

Examine circuits with solid state devices installed.

Review procedures for soldering electronic components.

Use a variety of resistors to demonstrate construction, use and testing.

COURSE GOAL:

The student will be able to service and install lead acid batteries.

PERFORMANCE INDICATORS:

Given a cutaway or clear-cased battery, the student will identify: negative and positive plate groups, negative and positive posts, separators, sediment chamber, plate strap and battery element.

Given a battery and hydrometer, the student will take specific gravity readings and record the level of electrical charge.

Given electrical test equipment and a fully charged battery, the student will complete a capacity (load) test.

Given a battery, proper chemicals and tools, the student will clean the battery case and terminals to instructor's approval.

Given a battery chart, and a battery in a live system, the student will remove and replace the battery and test the system for operation.

Given a series of battery acid or explosion hazards, the student will know and be able to apply first aid to eyes and skin in accidents involving acid spills or explosions.

SUGGESTED LEARNING ACTIVITIES:

Discuss battery application charts for various installations.

Visit a battery manufacturer or shop and observe batteries being built.

Discuss electrolytes and battery additives.

Demonstrate safety procedures for handling, cleaning and storing batteries and electrolytes.

Discuss the periodic care and maintenance of batteries.

Discuss and demonstrate proper techniques for removing and installing batteries.

Demonstrate the appropriate use of a battery charger.

Discuss the dangers of hydrogen gas.

COURSE GOAL:

The student will be able to service and repair electric motors.

PERFORMANCE INDICATORS:

Given a horseshoe magnet, No. 14 copper wire, and a DC power source, the student will demonstrate the physics of electromagnetics.

Given a cranking motor, battery, test leads, test instruments, and bench vise, the student will demonstrate the no-load bench test.

Given AC/DC motors and proper tools, the student will disassemble, identify parts, reassemble, and test the motor for operation.

Given a live mechanical system, using AC/DC motors, appropriate tools and safety equipment, the student will remove and replace a motor.

Given an electric motor and the proper equipment, the student will disassemble, inspect, turn the commutator, test the windings, replace necessary parts, assemble and test the completed motor for proper operation.

SUGGESTED LEARNING ACTIVITIES:

Demonstrate testing procedures for starting circuits and switches.

Use service manuals to find specifications, as well as service and repair procedures.

Compare starting motors, electric motors, and generators for conductor sizes and construction generally.

Use films or bench models of electric motors to demonstrate bearing inspection and lubrication; testing of field circuits, grounds, armatures and solenoids; turning and dressing communicator; and full load test.

COURSE GOAL:

The student will be able to use a dwellmeter.

PERFORMANCE INDICATORS:

Given a dwellmeter and operating instructions, the student will calibrate the dwellmeter and demonstrate its hookup.

Given a dwellmeter and operating engines, the student will measure and record breaker point dwells for four, six and eight cylinder engines.

Given specification charts, dwellmeters, and internal combustion engines, the student will measure and adjust dwell to within one degree of specification.

SUGGESTED LEARNING ACTIVITIES:

Use reference materials to develop an understanding of 100% dwell for four, six and eight cylinder engines.

Use manufacturers' specifications.

Observe the effects of point dwell on ignition timing.

Compare feeler gap point settings to dwell degree settings.

# FLUID POWER SYSTEMS

COURSE GOALS

The student will be able to:

apply Bernoulli's Principle, Boyle's Law, Pascal's Law and Charles' Law to specific situations.

explain fluidics in writing and apply to specific situations.

identify fluid power component structures and functions.

build a basic fluid power system.

operate a fluid power system.

test a fluid power system.

service a fluid power system, and maintain the system in working order.

COURSE GOAL:

**The student will be able to apply Bernoulli's Principle, Boyle's Law, Pascal's Law and Charles' Law to specific situations.**

PERFORMANCE INDICATORS:

Given an atomizer bottle, cutaway of a simple carburetor, and air pressure, the student will demonstrate Bernoulli's Principle.

Given a container of compressed gas with attached pressure gauge, the student will demonstrate Boyle's Law.

Given balloons of different shapes, the student will demonstrate Pascal's Law.

Given a one gallon can and hot water, the student will demonstrate Charles' Law.

SUGGESTED LEARNING ACTIVITIES:

Use carburetor venturi, air pressure and vacuum gauge to demonstrate Bernoulli's Principle: As pressure increases velocity decreases.

Use a container of gas with an attached pressure gauge to demonstrate Boyle's Law: At a constant temperature, the volume of a gas varies inversely with its pressure.

Use a container with an attached gauge to demonstrate Pascal's Law: Pressure applied to a confined fluid acts equally in all directions, and at right angles to the container surfaces.

Use a glass bottle, one-hole stopper, length of rubber tubing and a U-tube partially filled with water to demonstrate Charles' Law: As the temperature of a gas increases the pressure will increase in the same ratio, as long as the volume remains constant.

Measure automobile tire pressure when tire is cold and when warm.

COURSE GOAL:

**The student will be able to explain fluidics in writing and apply to specific situations.**

PERFORMANCE INDICATORS:

Given written and verbal information, the student will write a technical paper on fluidics as a new field in fluid power technology.

Given a fluidics test bench, the student will identify components and their functions.

Given a fluidics test bench and circuit diagrams, the student will demonstrate basic circuit operation.

Given both electrical and fluidic circuits, the student will compare units of the fluidic system with comparable electrical system units.

SUGGESTED LEARNING ACTIVITIES:

Prepare an outline for a technical paper on fluidics, detailing writing procedures.

Observe a demonstration of a fluidics test bench.

Invite a guest speaker to discuss applications of fluidic principles, as well as employment prospects in this field.

Identify the following control panel features: air filter, pressure regulator, manometers, test gauges, flowmeters.

Set up circuits to demonstrate touch valves, proximity sensor, bellows actuated fluidic switch, and air pressure regulator.

COURSE GOAL:

**The student will be able to identify fluid power component structures and functions.**

PERFORMANCE INDICATORS:

Given fluid system components, the student will disassemble, identify parts, and explain the function of each in the system.

Given an operating fluid power system, the student will disassemble, clean parts with recommended solvent, assemble the system and test for proper operation.

Given basic fluid system components, the student will assemble a system and explain total circuit operation.

Given operating hydraulic systems, the student will identify and explain the purpose of reservoirs, oil coolers, hoses, pipes, tubes and couplers.

Given a sectional drawing of hydraulic system components, the student will explain how each operates.

SUGGESTED LEARNING ACTIVITIES:

Disassemble gear pump, vane pump, piston pump, flow controls, pressure valves, linear actuators, and rotary actuators.

Clean parts with recommended solvents, rinse each part, blow dry with compressed air, and coat with hydraulic oil before assembly.

(CAUTION–gum solvents and noncorrosive chemical cleaners should be used on metal parts ONLY. Do not allow these materials to come in contact with seals or packings.)

Examine air-to-oil coolers, water-to-oil coolers, fabric braid and wire braid hoses, copper, aluminum, plastic, and steel pipes and tubing, and fittings, adapters, and quick disconnect couplers.

COURSE GOAL:

The student will be able to build a basic fluid power system.

PERFORMANCE INDICATORS:

Given charts, manuals and diagrams, the students will identify the basic symbols used in schematics.

Using an operating fluid power system, the student will sketch the system using symbols to identify the components.

Given open-center and closed-center hydraulic systems, the student will explain component operation for each circuit.

Given a hydraulic circuit drawing and the hydraulic components, the student will build the hydraulic circuit, as well as determine and demonstrate the circuit's load capacity.

SUGGESTED LEARNING ACTIVITIES:

Review basic manuals for fluid power systems.

View a film of hydraulic systems.

Examine drawings of several systems.

Review the function and operation of each component in a basic hydraulic circuit.

Use a hydraulic test bench test and make operational each hydraulic component used in a basic hydraulic circuit.

COURSE GOAL:

The student will be able to operate a fluid power system.

PERFORMANCE INDICATORS:

Given an operating fluid power system, the student will demonstrate at least six safety rules an operator must follow.

The student will briefly describe in writing what damage might occur if a fluid power system were subjected to:

- too much heat
- too much pressure
- too much contamination
- too heavy loads
- shock (e.g., driving loaded forklift over railroad tracks or rough surfaces)

SUGGESTED LEARNING ACTIVITIES:

Build a basic hydraulic system.

Use a basic hydraulic system to demonstrate scientific laws pertaining to hydraulics.

Show industry films about hydraulic systems.

Visit construction sites and local manufacturing plants where hydraulic systems are utilized.

Perform a routine hydraulic system inspection.

Introduce troubleshooting practices for hydraulic systems.

COURSE GOAL:

The student will be able to test a fluid power system.

PERFORMANCE INDICATORS:

Given written and verbal directions, the student will outline a hydraulic testing procedure in writing.

Given live hydraulic equipment and test instruments, the student will test for leakage, pressure, as well as flow and heat conditions.

Given hydraulic test results, the student will record data and interpret results in writing.

Given hydraulic test results, the student will recommend service or repair work needed for the equipment.

Given a variety of basic hydraulic system drawings with flaws, the student will trace fluid flow and fluid pressure to the problem area and determine the probable cause(s) of the malfunctions.

SUGGESTED LEARNING ACTIVITIES:

Consult manuals and directions for hydraulic test instrument use.

Use manufacturers' specifications for specific pieces of hydraulic equipment.

Set up a basic hydraulic circuit and use check valves (stop flow) and flow control valves (flow limited) to cause system problems.

COURSE GOAL:

The student will be able to service a fluid power system and maintain the system in working order.

PERFORMANCE INDICATORS:

Given an operating fluid power system, the student will perform the following exercises to instructor's approval:

Service filter and screen; change fluid, select proper fluid, fill system to proper level; inspect system for leaks; test system for proper operation; inspect for any air in system, broken linkage, damaged hoses, mounting brackets, loose fittings; approve or reject system for further use.

Given a fluid power system, replacement parts and tools, the student will replace faulty lines and other components, and inspect the system for proper operation.

Given a fluid power system, the student will develop, maintain and record in writing recommended service procedure, as well as a schedule for periodic servicing.

SUGGESTED LEARNING ACTIVITIES:

Disassemble and assemble filters.

Demonstrate cleanliness procedures for working on fluid power systems.

Use operator's manual and a live system to demonstrate appropriate service procedures.

Disassemble and assemble system lines; make new lines; bleed air from system.

Develop a system for maintenance and record keeping.

# CAREER PREPARATION

COURSE GOALS

The student will be able to:

write letters of application and business.

speak from prepared notes.

use industrial mechanics' reference manuals and catalogs.

sketch specifications to convey ideas to others.

list job characteristics for industrial mechanics.

explain in writing the basic functions of organized labor and apprenticeship programs.

describe in writing the characteristics of employer-employe relationships.

apply job-search techniques.

prepare a personal resume and complete a job application form.

develop a training plan in writing for job entry.

COURSE GOAL:

The student will be able to write letters of application and business.

PERFORMANCE INDICATORS:

Given several job situations, the student will determine whether a letter of application could be used.

Using reference materials, the student will write a letter of application.

The student will write an acceptable business letter emphasizing clear, concise writing and which shows consideration for the reader.

SUGGESTED LEARNING ACTIVITIES:

Obtain sample letters from local businesses for students to use as models.

Evaluate sample business letters for purpose and expected response.

Rate student business letters for effectiveness.

Write letters of application to practice format and content development.

Participate in VICA activities and prepare for skills olympics competition.

COURSE GOAL:

The student will be able to speak from prepared notes.

PERFORMANCE INDICATORS:

Given a list of topics, the student will select a topic and write a speech that informs, persuades and entertains.

Given a list of topics, the student will select one, develop a written outline for a five minute extemporaneous presentation, and make the presentation.

Using a rating form, the student will evaluate another speaker's presentation.

SUGGESTED LEARNING ACTIVITIES:

Listen to speeches given by instructor and others.

Consult the language arts department for material and suggestions.

Show movies on speaking techniques.

Use a cassette recorder to practice speaking.

Participate in VICA skills olympics, "Club Business Procedure" (prepared speech, opening/closing ceremonies, extemporaneous speaking, job interview techniques, etc.)

COURSE GOAL:

The student will be able to use industrial mechanics reference manuals and catalogs.

PERFORMANCE INDICATORS:

Given shop manuals, and a list of specific makes and models of automobiles, the student will match engine technical data with the automobiles.

Given parts catalogs and a list of parts for a particular piece of equipment, the student will identify the parts by number and description.

Given a list of questions asking for technical data, the student will use manuals and charts to find and record the answers.

SUGGESTED LEARNING ACTIVITIES:

Visit a parts department in business or industry.

Measure reading and comprehension abilities of students.

Practice reading and interpreting data plate information.

Participate in VICA activities and prepare for the VICA skills olympics.

Complete each level of the VICA Initiative and Achievement program.

COURSE GOAL:

The student will be able to sketch specifications to convey ideas to others.

PERFORMANCE INDICATORS:

Given an electrical, mechanical or fluid system, the student will sketch, label and write an operational description for the system.

Given a small object, drawing equipment, and instructions, the student will complete an isometric drawing of the object.

SUGGESTED LEARNING ACTIVITIES:

Visit a drafting class.

Observe demonstration of sketching and drawing techniques.

Set up for approval basic drafting equipment.

Reproduce the alphabet using a lettering guide, also, numbers 0 – 9.

Select an object and complete front, side, and top view drawings.

Complete an isometric drawing of the object in the above activity.

Sketch an operational system for equipment in the school shop.

COURSE GOAL:

The student will be able to list job characteristics for industrial mechanics.

PERFORMANCE INDICATORS:

Given descriptions of industrial mechanics occupations, the student will select those of interest and identify the skills required, identify worker responsibilities, and explain related working conditions.

Given an opportunity to choose and visit an industry to observe an occupational setting, the student will describe job characteristics (e.g., skills required, working conditions, responsibilities).

Given a list of jobs (from skilled through the professional levels), the student will select ten in each of the following:

Technology–skilled
Technology–professional
Technology–mechanical

SUGGESTED LEARNING ACTIVITIES:

Use the *Dictionary of Occupational Titles, Occupational Outlook Handbook* to gather data about jobs.

Interview or talk with workers.

Arrange a field trip to local businesses and industrial sites.

Use "Career Information Services" (CIS) needle-sort or computer program for information.

Obtain information from the U.S. Department of Labor, apprenticeship councils, labor organizations, and labor unions.

Explain the ladder-of-jobs concept for skilled and professional workers.

Invite speakers from IPAR (Institute for Public Affairs Research) or other community groups.

COURSE GOAL:

**The student will be able to explain in writing the basic functions of organized labor and apprenticeship programs.**

PERFORMANCE INDICATORS:

Given the opportunity to talk to union members, social studies teachers, and people in economics, the student will list what's involved in collective bargaining and contracts.

The student will outline in writing what's involved in an apprenticeship training program for an industrial mechanics occupation.

Given a case study of a grievance, the student will recommend a solution, citing reasons for the choice.

Given information about organized labor, the student will write a brief description of work groups and their goals.

SUGGESTED LEARNING ACTIVITIES:

Plan cooperative interdisciplinary instruction with the social studies department to explain the history of labor organizations.

Invite union members, apprentices, and people from the trades to class to discuss their jobs and responsibilities.

Obtain information about apprenticeship openings from local business and apprenticeship offices.

Obtain a copy of a specific apprenticeship training program and compare it with other post-secondary occupational study options.

Participate in VICA activities.

COURSE GOAL:

**The student will be able to describe in writing the characteristics of employe/employer relationships.**

PERFORMANCE INDICATORS:

Given a list of work characteristics, the student will know what employers consider desirable.

Given employment guidance information, the student will prepare a list of ways to advance on-the-job.

Given a list of rights and responsibilities for employers and employes, the student will know the reasons for these and what job applicants can expect.

SUGGESTED LEARNING ACTIVITIES:

Invite guests to class to talk about their jobs.

Consult employment agencies for job information.

Invite key labor and management persons to speak to the class about employer expectations.

Discuss work attitudes, the profit motive, and other job related factors.

Review organized labor studies on why workers are fired.

Have students practice good housekeeping: sweep floors, clean benches, clean parts before working on them, clean up oil spills, etc.

Participate in VICA activities.

COURSE GOAL:

The student will be able to apply job-search techniques.

PERFORMANCE INDICATORS:

Given employment reference materials, the student will list ten sources of employment assistance.

Given information from counselors, guidance personnel, and the work experience coordinator, the student will outline a procedure for seeking employment.

Given prepared interview materials and the help of other persons, the student will take part in a hypothetical interview.

Given job-search information, the student will develop in writing an interview follow-up procedure.

SUGGESTED LEARNING ACTIVITIES:

Ask an employment agency representative to class to discuss job search techniques.

Develop a list of job prospects.

Practice writing letters of response to help wanted ads.

Discuss the benefits offered by various types of businesses.

Ask a number of people to describe how they went about getting a job.

Have students simulate job interview situations. Record conversations and critique as a class.

Ask local business or industry representatives to conduct interviews with students.

Enter the VICA Job Interview contest.

COURSE GOAL:

**The student will be able to prepare a personal resume and complete a job application form.**

PERFORMANCE INDICATORS:

Given a resume outline, the student will supply the following:

- Personal data
- Educational background
- Previous employment
- Extracurricular activities
- Special skills and aptitudes
- Community activities
- References

Given different job application forms, the student will complete two satisfactorily.

SUGGESTED LEARNING ACTIVITIES:

Make a list of personal likes, and gear this list to job choices.

Obtain job information from the State Employment Service.

Consult the counseling center for job search information.

Contact businesses which are accepting job applications.

Participate in VICA activities.

COURSE GOAL:

The student will be able to develop a training plan in writing for job entry.

PERFORMANCE INDICATORS:

Given employment information (e.g., newspaper, state employment, organized labor, private placement, direct contact, etc.), the student will indicate the employment opportunities available in seven key occupations in industrial mechanics.

Given an opportunity to visit a work site where industrial mechanics occupations are needed, the student will analyze and develop training plans in writing for job entry.

SUGGESTED LEARNING ACTIVITIES:

Use state manpower information for job outlook forecasting.

Invite speakers from business and industry to discuss job-entry skills.

Discuss occupational choice with teachers, fellow students, and parents.

Visit schools, businesses, and military recruiters to discuss training program opportunities.

Invite a personnel manager to class.

Visit an employment agency.

Have students scan newspaper ads and list various "Help Wanted" notices for jobs in industrial mechanics.

Participate in VICA activities (e.g., job interviews and tests).

# ASSESSMENT

## ASSESSMENT*

Why assess? Assessment is critical to sound instructional planning. Once a school and its community reach a mutual understanding of what schooling is to accomplish (once goals and graduation requirements are set), there is a need to know whether such outcomes are being reached.

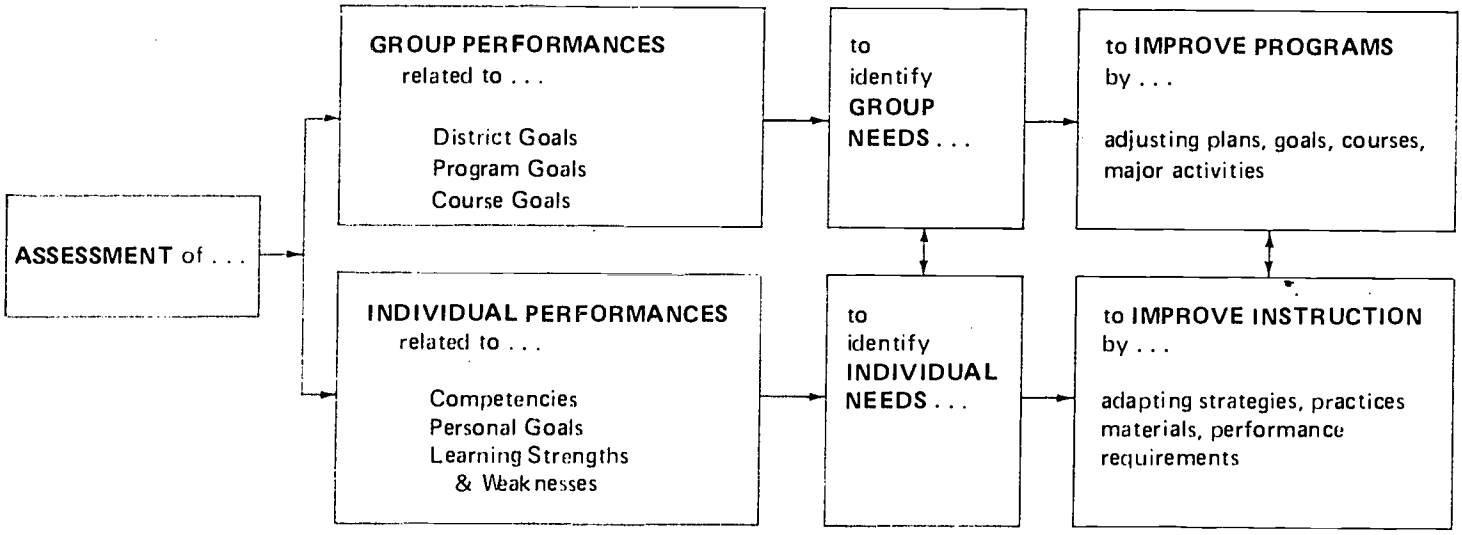
In the Goal-Based Planning for Industrial Mechanics Programs section of this guide, four sets of desired outcomes were identified: state goals, district goals, program goals and course goals.

Once instructional plans are implemented, the instructor must pose the question: Are students attaining desired outcomes, and is the industrial mechanics program helping them to reach those outcomes: The quality of the answers to these questions depends on how well assessment activities are designed and carried out.

Assessment activities involve both group and individual approaches: how well students do in the program as a group helps determine the course of the program; how well students do individually helps instructors map out teaching strategies.

The interrelationship is shown below. Assessment of each of the elements shown in the figure will provide answers to particular kinds of questions.

### ASSESSMENTS OF GROUP AND INDIVIDUAL PERFORMANCES




*Assessment in goal-based planning is described on pages 17-30 in the *Elementary-Secondary Guide for Oregon Schools: Part II, Suggestions* (Salem: Oregon Department of Education, 1977).

**District goal assessment** answers the question: To what extent are students attaining the outcomes of schooling the community and its schools desire?

**Program goal assessment** answers the question: To what extent are students attaining the outcomes industrial mechanics teachers and curriculum planners desire?

**Course goal assessment** answers the question: To what extent are students attaining the outcomes industrial mechanics teachers desire for "The Cooling System?"

**Assessment of personal goals** answers the question: To what extent is a student attaining those outcomes designated as of greatest personal importance, need, or interest?

**Assessment of learning strengths and weaknesses** answers the question: What characteristics reflected by a student's performance can be seen as enhancing or inhibiting attainment of desired outcomes?

In seeking answers to these questions, student performances that can be accepted as indicators of attainment of desired outcomes must be clear. These performance indicators serve to guide the assessment activity in producing the most needed information.

Assessment might involve several of the following approaches:

- Third party assessment (teachers, parents, educators, advisory committees)
- Administrative assessment
- Student assessment of the program, instruction, as well as the level of personal satisfaction
- Use of student monitoring data*
- Student pre-test and post-test to determine student growth*
- Student follow-up study*
- Survey questionnaires*
- An industrial mechanics assessment/planning guide

*Program Evaluation Skills for Busy Administrators* (Portland: Northwest Regional Laboratory, 1977).

# APPENDIX

A. Job Descriptions from the *Dictionary of Occupational Titles*

B. Machines and General Equipment

C. Instructional Analysis for Organizing Learning Experiences

# APPENDIX A

## JOB DESCRIPTIONS FROM THE DICTIONARY OF OCCUPATIONAL TITLES

O.E.S.* No. 51008
D.O.T. No. 620.181; Mechanic, Automotive

Repairs and overhauls automobiles, buses, trucks and other automotive vehicles.

O.E.S. No. 51002
D.O.T. No. 621.218; Mechanic, Aircraft

Services, repairs and overhauls aircraft engines. Repairs, replaces and assembles parts such as wings, fuselage, tail assembly, landing gear, control cables, propeller assembly and fuel and oil tanks, using tools such as power shears, sheet metal breaker, arc and acetylene welding equipment, rivet gun and air or electric drills to rebuild airframe or its components.

O.E.S. No. 51031
D.O.T. No. 625.281; Gasoline Engine Repairer, Fractional Horsepower (Small Engine Mechanic)

Repairs fractional horsepower gas engines used to power boats, lawnmowers, brushsaws, garden tractors and similar machines, using hand tools.

O.E.S. No. 51052
D.O.T. No. 637.281; Refrigeration Mechanic

Installs, services and repairs refrigeration and cooling systems according to blueprints and engineering specifications using knowledge of refrigeration, structural layout, and function and design of components.

O.E.S. No. 51046
D.O.T. No. 633.281; Office Machine Repairer

Repairs and services office machines such as adding, accounting, calculating, typewriters and other business machines, such as cash register and duplicating machines.

O.E.S. No. 55B95
D.O.T. No. 638.281; Millwright

Installs new machinery and heavy equipment according to layout plans, blueprints and other drawings in an establishment, and dismantles and moves machinery and heavy equipment when changes in plant layout are required. Uses a variety of hand tools, hoists, dollies and trucks. May construct foundation for machines.

O.E.S. No. 51034
D.O.T. No. 620.281; Engineering Equipment Mechanic

Analyzes malfunctions and rebuilds, repairs, and adjusts heavy construction equipment other than internal combustion engines, such as cranes, shovels, scrapers, paving machines, motor graders, rock crushers, trench-digging machines, conveyors and bulldozers.

O.E.S. No. 51019
D.O.T. No. 625.281; Diesel Mechanic (includes hydraulics mechanic)

Repairs and maintains diesel engines used to power machinery such as autos, buses, trucks, ships, electric generators and construction machinery, using hand tools and precision measuring instruments and metalworking tools.

*Occupational Employment Statistics.

## APPENDIX B

## MACHINES AND GENERAL EQUIPMENT

Tools and equipment should be supplied for all activities. Goals and performance indicators can help decide which tools are needed.

Air Conditioning Trainer
Alternator-Generator-Regulator Test Stand
Ampmeter, AC/DC
Analyzer, Capacitor
Analyzer, Engine (scope, exhaust HC/CO)
Anvil*
Battery Eliminator and Charger
Bleeder, Brake
Boring Bar (cylinder set)
Can, Carwash*
Can, Oil filler and measure (1 quart)
Can, Oil filler and measure (2 quart)
Can, Oil filler and measure (5 quart)
Can, Oily waste
Can, Radiator
Can, Safety (1 quart)
Can, Safety (1 gallon)
Carburetor Repair set
Cleaner, Spark plug
Cleaner, Valve guide
Compression Gauge
Continuity Light
Crane, Portable
Drill, Electric, Portable (1/4")
Drill, Electric, Portable (3/8")
Drill, Electric, Portable (1/2")
Dwellmeter
Engine, Automobile
Engine, Diesel
Engine, Outboard
Engine, Rocket (small or model)*
Engine, Small (2-cycle)
Engine, Small (4-cycle)
Engine Stand
Engine, Steam (model)*
Engine, Turbine (small)*
Funnel, Longspout, Automatic transmission
Gauge Set, Air Conditioning
Grease Gun
Grease Gun, Chassis
Grease Gun, Extended interval
Grease Gun, Gear lube
Grinder, Edge tool (bench)
Grinder, Flexible chaft
Grinder, Pedestal
Grinder, Valve (set)
Growler, Armature testing
Gun, Engine cleaning
Hoist, Double post
Hoist, Single post*
Hone, Brake cylinder (set)
Hone, Cylinder (to 7")*
Hone, Pin*
Hydraulic Instruction Unit
Jack, Auto bumper (double-saddle type)
Jack, Auto, Hydraulic (floor type, 1½ ton)
Jack, Auto, Hydraulic (standard type) (1½ ton)
Jack, Auto, Hydraulic (standard type) (2 ton)
Lamps, Drying (set)*
Lathe, Armature
Lathe, Metalworking (10")
Lift, Engine safety
Milliammeter, Volt-ohm AC/DC
Motor Stand, Universal*
Ohmmeter
Office Machines and Equipment (used)
Pneumatic Instruction Center
Polisher, Body*
Press, Drill (15")
Press, Drill (17")
Puller, Auto body metal (set)*
Radiator Test Plugs (set)
Reamer, Expansion (set)
Reamer, Valve seat (set)
Refacer, Valve (set)
Refrigerator (used)
Sander, Finishing, Portable, Air*
Spray Gun Outfit*
Tachometer (electrical, mechanical)
Tank, Chemical
Tank, Parts cleaning, solvent
Tester, Coil and condenser
Tester, Distributor
Timing Light (portable)
Truck, Welding cylinder
Tubing Kit (cut, bend, flare)
Vise, Machinist's bench
Voltmeter AC/DC
Welder, Arc
Welding Outfit, Oxyacetylene
Wheel Alignment Set*
Wheel Balancer

*Optional

## GENERAL FURNISHINGS

Bench, Metalworking (4 place)
Bookcase
Broom, Push
Brush, Bench
Cabinet, Filing
Chair, Teacher's
Compressor, Air
Desk, Teacher's
Fire Blanket
Fire Extinguisher – A, B, C, D
First Aid Kit
Hose, Air
Hose, Exhaust, Garage
Hose, water
Pan, Dust
Pencil Sharpener, Standard
Projector, Filmstrip (35mm) and slide (2" x 2")
Projector, Motion picture, Sound
Projector, Overhead
Screen, Projection
Stand, Auto safety (2 ton)
Stand, Auto safety (7 ton)
Table, Overhead projector
Tape Recorder or Tape Deck
Welding Screen, Portable

## TOOLS AND EQUIPMENT

Air Wrench (hammer, chisels, sockets)
Bar, Pry
Battery, Storage (6V)
Battery, Storage (12V)
Battery Tools (cleaner, carrier, etc.)
Brake Adjusting Tool (spoons) (set)
Brake Bleeder
Brush, Wire
Caliper, Hermaphrodite
Caliper, Inside (6")
Caliper, Outside (6")
Caliper, Venier
Chisel, Cold (set)
Clamp, "C" (4")
Clamp, "C" (6")
Clamp, "C" (8")
Clamp, "C" (10")
Cleaner, Ring groove
Compressor, Piston ring
Compressor, Valve spring
Creeper
Cutter, Bolt
Cutter, Brushing
Cutter, Muffler (for air tool)
Cutter, Pipe
Cutter, Tubing
Die, Letter (set)
Die, Number (set)
Divider, Spring (6")
Dolly, Body (set)*
Dresser, Abrasive wheel
Drill, Hand (1/4")
Drill, Hand (3/8")
Drill Stand, Fractional
Drill, Twist (number set)
Drill, Twist, Straight shank (fractional set)
Electric Wrench
Extension Cord
Extractor, Screw (set)
Files (see specifications for set detail)
File Card and Brush
File, Contact Point (ignition)
Flaring Tool (set)
Flywheel holder
Gauge, Belt tension
Gauge, Carburetor (set)
Gauge, Center
Gauge, Cylinder pressure
Gauge, Drill, Fractions
Gauge, Drill, Number
Gauge, Ignition (set)
Gauge, Screw pitch
Gauge, Spark plug
Gauge, Spring tension
Gauge, Surface
Gauge, Thickness ("feeler")
Gauge, Tire pressure
Gauge, Vacuum and low pressure
Gauge, Wire and sheet metal (American)
Gauge, Wire and sheet metal (U.S.S.)
Gloves, Leather (pair)
Goggles (spectacles), Clear observation

*Optional

Goggles, Gas welding
Grease Gun, Suction, General purpose
Hack Saw (hand)
Hammer, Ball peen (4 oz.)
Hammer, Ball peen (8 oz.)
Hammer, Ball peen (16 oz.)
Hammer, Brass head
Hammer, Chasing
Hammer, Chipping
Hammer, Claw (16 oz.)
Hammer, Engineer's (40 oz.)
Hammer, Lead
Hammer, Sledge
Hammer, Soft face (8 oz.)
Helmet, Welding (hand type)
Helmet, Welding (arc) (head type)
Hydrometer (battery and coolant)
Indicator, Dial test
Mallet, Rawhide
Mallet, Rubber
Micrometer, Inside
Micrometer, Outside (1")
Micrometer, Outside (2")
Micrometer, Outside (3")
Micrometer, Outside (4")*
Micrometer, Outside (5")*
Nipper, End cutting
Nozzle, Blow gun (air line)
Oiler, Bench
Oiler, Pump
Oiler, Straight
Oilstone, Combination, India
Oilstone, Combination, Silicon carbide
Packer
Pliers, Battery
Pliers, Brake
Pliers, Chain
Pliers, Combination (6")
Pliers, Combination (8")
Pliers, Diagonal cutting
Pliers, Hose clamp, Radiator and gas line
Pliers, Ignition
Pliers, Needle nose
Pliers, Retaining ring
Pliers, Side-cutting
Pliers, Vise-grip wrench
Press, Arbor
Puller Assembly
Puller Assembly (large)
Puller, Axle*
Puller, Freeze plug
Puller, Gear (set)
Puller, Seal (set)
Puller, Steering wheel
Puller, Valve guide and valve
Puller, Wheel (set)
Pump, Oil drum
Punch, Center, Pin, Drift (sets)
Reamer, Cylinder ridge
Reels, Drop cord
Remover, Stud (set)
Rethreader, Axle*
Rethreader, Spark plug hole
Rule, Flexible steel tape (10')
Rule, Steel (12")
Scissors
Scraper, Carbon
Screwdriver, Clutchhead
Screwdriver, Phillips (set)
Screwdriver, Spiral ratchet
Screwdriver, Standard bit (square blade) (4")
Screwdriver, Standard bit (square blade) (6")
Screwdriver, Standard bit (square blade) (8")
Screwdriver, Standard bit (square blade) (10")
Screwdriver, Standard bit (square blade) (12")
Screwdriver, Standard bit ("stubby")
Seal/Bushing Driver Set
Shield, Face
Snips, Tinner's Straight (No. 8)
Soldering Gun, Electric Iron, Propane Torch
Spout, Pouring, Oil can
Strap, Battery
Tap and Die, NC (U.S.S.) (set)
Tap and Die, NF (S.A.E.) (set)
Tap and Die, Pipe (set)
Tester, Battery cell
Tester, Radiator pressure
Tool, Drag link and shock arm
Tool Holder, Lathe (left hand)
Tool Holder, Lathe (right hand)
Tool Holder, Lathe (straight)
Torch, Propane (kit)
Wire Stripper
Wrench, Adjustable end (8")
Wrench, Adjustable open end
Wrench, Allen key (hex) (set)
Wrench, Combination box and open end (set)

*Optional

Wrench, Combination box and open end (metric) (set)
Wrench, Deep socket (3/8" drive) (set)
Wrench, Deep socket (1/2" drive) (set)
Wrench, Drain plug
Wrench, Flare nut (set)
Wrench, Ignition (set)
Wrench, Lug
Wrench, Pipe (10")
Wrench, Pipe (18")
Wrench, Socket (1/4" drive) (set)
Wrench, Socket (3/8" drive) (set)
Wrench, Socket (1/2" drive) (set)
Wrench, Socket (metric) (set)
Wrench, Socket, Flex handle (3/8" drive)
Wrench, Socket, Flex handle (1/2" drive)
Wrench, Socket, Handle extension (3/8" drive) (3")
Wrench, Socket, Handle extension (3/8" drive) (4")
Wrench, Socket, Handle extension (3/8" drive) (set)
Wrench, Socket, Handle extension (1/2" drive) (8")
Wrench, Socket, Handle extension (1/2" drive) (set)
Wrench, Socket, Reversible ratchet handle (1/4" drive)
Wrench, Socket, Reversible ratchet handle (3/8" drive)
Wrench, Socket, Reversible ratchet handle (1/2" drive)
Wrench, Socket, Handle extension (1/2" drive) (3")
Wrench, Socket, Speed handle (1/4" drive)
Wrench, Socket, Speed handle (3/8" drive)
Wrench, Socket, Speed handle (1/2" drive)
Wrench, Socket, Universal joint attachment (1/4" drive)
Wrench, Socket, Universal joint attachment (3/8" drive) (set)
Wrench, Socket, Universal joint attachment (1/2" drive) (set)
Wrench, Tappet (set)
Wrench, Torque (3/8" drive)
Wrench, Torque (1/2" drive)

## APPENDIX C

## INSTRUCTIONAL ANALYSIS FOR

## ORGANIZING LEARNING EXPERIENCES

| | AUTOMOBILE MECHANIC | DIESEL MECHANIC | AUTO SERVICE MECHANIC | CONSTRUCTION EQUIP. MECHANIC | REFRIGERATOR MECHANIC | SMALL ENGINE MECHANIC | AVIATION MECHANIC | OFFICE MACHINE MECHANIC | MAINTENANCE MECHANIC | MILLWRIGHT | STATIONARY ENGINEER | HYDRAULIC MECHANIC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEASUREMENT | | | | | | | | | | | | |
| Use linear tapes and rules (English and metric) | | | | | | | | | | | | |
| Select and Use | | | | | | | | | | | | |
| Ammeter | | | | | | | | | | | | |
| Voltmeter | | | | | | | | | | | | |
| Stethoscope | | | | | | | | | | | | |
| Exhaust Gas Analyzer and Oscilloscope | | | | | | | | | | | | |
| Ohmmeter | | | | | | | | | | | | |
| Tachometer | | | | | | | | | | | | |
| Dwellmeter | | | | | | | | | | | | |
| Hydrometer | | | | | | | | | | | | |
| Pressure Gauges | | | | | | | | | | | | |
| Temperature Gauges | | | | | | | | | | | | |
| Calipers | | | | | | | | | | | | |
| Feeler Gauges | | | | | | | | | | | | |
| Thread Gauges | | | | | | | | | | | | |
| Spring Scales | | | | | | | | | | | | |
| Micrometers | | | | | | | | | | | | |
| Dial Indicators | | | | | | | | | | | | |
| Plug Gauges | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| HAND TOOLS (proper use of, safe use of) | | | | | | | | | | | | |
| Identify | | | | | | | | | | | | |
| Select for specific use | | | | | | | | | | | | |
| Maintenance of | | | | | | | | | | | | |
| Reconditioning of | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| MACHINE TOOLS (proper use, safety with) | | | | | | | | | | | | |
| Portable Electric Drill | | | | | | | | | | | | |
| Drill Press | | | | | | | | | | | | |
| Portable Buffer/Grinder | | | | | | | | | | | | |
| Impact Wrench | | | | | | | | | | | | |
| Lathe | | | | | | | | | | | | |
| Bench and Pedestal Grinders | | | | | | | | | | | | |
| Valve Face and Valve Seat surfacing equipment | | | | | | | | | | | | |

## INSTRUCTIONAL ANALYSIS FOR

## ORGANIZING LEARNING EXPERIENCES

| | AUTOMOBILE MECHANIC | DIESEL MECHANIC | AUTO SERVICE MECHANIC | CONSTRUCTION EQUIP. MECHANIC | REFRIGERATOR MECHANIC | SMALL ENGINE MECHANIC | AVIATION MECHANIC | OFFICE MACHINE MECHANIC | MAINTENANCE MECHANIC | MILLWRIGHT | STATIONARY ENGINEER | HYDRAULIC MECHANIC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAFETY | | | | | | | | | | | | |
| Receive oral and written instructions | | | | | | | | | | | | |
| Inspect for compliance with local, state laws | | | | | | | | | | | | |
| Fire protection | | | | | | | | | | | | |
| Housekeeping | | | | | | | | | | | | |
| Material handling | | | | | | | | | | | | |
| Electrical safety | | | | | | | | | | | | |
| Machine guarding | | | | | | | | | | | | |
| First Aid procedures | | | | | | | | | | | | |
| Reports and records | | | | | | | | | | | | |
| Use personal safety measures at all times | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| TECHNICAL KNOWLEDGE | | | | | | | | | | | | |
| Identify and explain simple machines | | | | | | | | | | | | |
| Demonstrate electric power generation | | | | | | | | | | | | |
| Interpret specifications (English and metric) | | | | | | | | | | | | |
| Use terminology consistent with the occupation | | | | | | | | | | | | |
| Demonstrate fluid power principles (all fluids) | | | | | | | | | | | | |
| Read and interpret manufacturers' manuals | | | | | | | | | | | | |
| Follow instructions for equipment operation | | | | | | | | | | | | |
| Read wiring diagrams and blueprints | | | | | | | | | | | | |
| Interpret charts and graphs | | | | | | | | | | | | |
| Add, subtract, multiply, and divide | | | | | | | | | | | | |
| Whole numbers | | | | | | | | | | | | |
| Fractions | | | | | | | | | | | | |
| Decimals | | | | | | | | | | | | |
| Translate printed information into action learning | | | | | | | | | | | | |
| Identify sources of technical information | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| COMMUNICATION | | | | | | | | | | | | |
| Collect and organize data | | | | | | | | | | | | |
| Conclude from data and communicate with others | | | | | | | | | | | | |
| Demonstrate a concept to other people | | | | | | | | | | | | |
| Use telephone | | | | | | | | | | | | |
| Give accurate oral instructions to others | | | | | | | | | | | | |
| Read and write business letters | | | | | | | | | | | | |
| Develop listening skills | | | | | | | | | | | | |

## INSTRUCTIONAL ANALYSIS FOR

## ORGANIZING LEARNING EXPERIENCES

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMMUNICATION (continued) | | | | | | | | | | | | |
| Complete an accurate job application | | | | | | | | | | | | |
| Pass a sample job interview | | | | | | | | | | | | |
| Prepare a personal data sheet or resume | | | | | | | | | | | | |
| Develop leadership ability | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| MAINTENANCE AND REPAIR TECHNIQUES | | | | | | | | | | | | |
| Disassemble/assemble mechanical equipment | | | | | | | | | | | | |
| Disassemble/assemble electrical equipment | | | | | | | | | | | | |
| Disassemble/assemble fluid power equipment | | | | | | | | | | | | |
| Use appropriate parts cleaning procedures | | | | | | | | | | | | |
| Test electrical components for proper operation | | | | | | | | | | | | |
| Use words, numbers, or other symbols to mark parts | | | | | | | | | | | | |
| Determine or select one procedure over others | | | | | | | | | | | | |
| Diagnose using sight, smell, touch, and hearing | | | | | | | | | | | | |
| Use manipulative sequencing | | | | | | | | | | | | |
| Determine serviceability of mechanical parts | | | | | | | | | | | | |
| Service equipment to manufacturer's specifications | | | | | | | | | | | | |
| Properly use lifting equipment (hoist, jack, etc.) | | | | | | | | | | | | |
| Properly use arc welding equipment and techniques | | | | | | | | | | | | |
| Properly use gas welding equipment and techniques | | | | | | | | | | | | |
| Use proper soldering equipment and techniques | | | | | | | | | | | | |
| Select and use fastening devices | | | | | | | | | | | | |
| Keep maintenance and repair records | | | | | | | | | | | | |
| Start engines or equipment to listen to operation | | | | | | | | | | | | |
| Remove and replace mechanical components | | | | | | | | | | | | |
| Remove and replace electrical components | | | | | | | | | | | | |
| Remove and replace fluid power components | | | | | | | | | | | | |
| Inspect and repair equipment for return to service | | | | | | | | | | | | |
| Prepare equipment for climate change | | | | | | | | | | | | |
| Prepare engines and equipment for storage | | | | | | | | | | | | |
| Diagnose electro/mechanical equipment problems | | | | | | | | | | | | |
| Adjust equipment to manufacturer's specifications | | | | | | | | | | | | |
| Properly use seals, gaskets, and sealants | | | | | | | | | | | | |
| Practice hand dexterity and manipulative techniques | | | | | | | | | | | | |
| Test metals for hardness | | | | | | | | | | | | |
| Use hardening and tempering techniques | | | | | | | | | | | | |

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